210
GENERAL LIBRARY
UNIV. OF MICH.

Vol. XXXII, No. 4

APP A Whole No. 276

APRIL, 1932

SCHOOL SCIENCE AND MATHEMATICS

FOUNDED BY C. E. LINEBARGER

A Journal for all SCIENCE AND MATHEMATICS TEACHERS

CONTENTS:

Animal Ecology

Cultural Physics

High School Biology

A Test in Logarithms

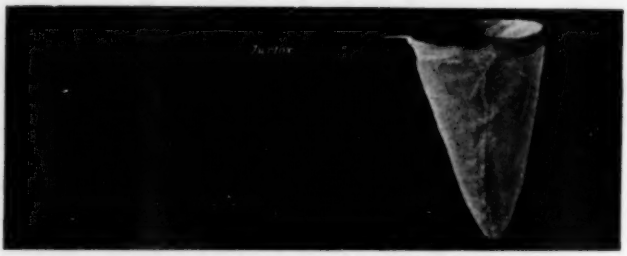
Nature Counselors

Visual Education

Published by THE CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS
Publication Office: 404 N. WESLEY AVE., MOUNT MORRIS, ILLINOIS
Business Office: 3319 N. FOURTEENTH ST., MILWAUKEE, WISCONSIN
Editorial Office: 7633 CALUMET AVE., CHICAGO, ILLINOIS

Published monthly, October to June, Inclusive, at Mount Morris, Illinois *Price, $2.50 Per Year: 30 Cents Per Copy*
Entered as second-class matter March 1, 1918, at the Post Office at Mount Morris, Illinois, under the Act of March 3, 1879

Turtox Collecting Nets



105A10 TURTOX DOLLAR NET.

The Turtox Dollar Insect Net is a popular light-weight net for student use and an unusual value. Nicely varnished hardwood handle 30 inches long. Ring, 12 inches in diameter. Bag of fine-meshed netting, 18 inches deep, reinforced at top edge by double muslin band.

No. 105A10 *Turtox Dollar Net*, each.....$1.25
In lots of 12 or more, each..... 1.00

TURTOX PRODUCTS

The Sign of the Turtox Pledges Absolute Satisfaction

Ask for a copy of our 1932 net circular describing and illustrating Turtox Collecting nets for every purpose.

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
761-763 EAST SIXTY-NINTH PLACE
CHICAGO

For the First Two Years

Hunter & Whitman's Problems in General Science Hunter's Problems in Biology

Each book, covering a year's work, is organized in Units with survey questions and a preview for each Unit.

Each book contains complete teaching aids, such as Self-testing Exercises, Fundamental Concept Tests, Achievement Tests, Demonstrations, and Practical Exercises.

AMERICAN BOOK COMPANY

New York Cincinnati Chicago
Boston Atlanta

SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXII NO. 4 APRIL, 1932 WHOLE NO. 276

AN EXPERIMENT IN VISUAL EDUCATION IN ELEMENTARY COLLEGE CHEMISTRY*

BY B. S. HOPKINS AND H. G. DAWSON

University of Illinois, Urbana, Ill.

During recent years it has been the custom at the University of Illinois to show motion picture films to some of the advanced classes, especially those who are interested in certain industrial processes. Frequently students from the elementary classes were invited to witness these displays and many films of particular interest to the Freshmen were shown for their special benefit. These showings were not made during regular class hours and attendance was optional. In general the interest was good, but there was no indication that these efforts were improving scholarship, increasing interest or promoting the welfare of chemical education.

In February, 1931, the Freshman classes were moved into a new building which had complete equipment for showing silent motion pictures. Accordingly it was decided to undertake a study of the educational value of motion pictures, film slides and regular lantern slides, when these are incorporated in the regular lecture work of a course. The time of one assistant was devoted to various problems connected with the study, such as the collection of material, editing of films, making suitable slides, arranging and cataloging material and operation of the projectors.

It was concluded that if visual education was to be successfully applied to our problem it must be incorporated as

*Presented before the Symposium on Visual Aids of the Division of Chemical Education at the A. C. S. meeting, Buffalo, September 2, 1931.

an integral part of the regular sessions of the class. Accordingly the plan selected was to present during the regular lecture periods, either lantern slides or motion picture films to illustrate the topic under discussion. This plan involved three very important considerations: (1) a very careful study of available material with the presentation limited to those portions which are of definite educational value in the teaching of chemistry; (2) a complete understanding between the lecturer and the operator regarding what materials are to be shown and the order of their display; (3) a decided modification of the lecture plan in order to save time and to bring out without repetition the full educational value of the various visual aids. A somewhat extended study of each of these considerations is worth while.

Our first problem was to make a comprehensive study of material available for visual education purposes. Accordingly the semester outline was carefully scrutinized and all suitable topics were selected. Thorough search was made for slides and motion picture films based upon these topics and for pictures or drawings from which illustrative material could be prepared. After diligent search we concluded that we should be compelled to make our own slides since those available were not suited to our purpose. Accordingly many slides were made to furnish such illustrations as would permit the lecturer to present his material more clearly, more concisely or with greater interest. At first these slides were prepared from all available sources such as the illustrations and diagams in textbooks, periodicals and advertising literature, but this search consumed too much time and after all did not give a complete set of slides. It is more efficient to study thoroughly the material to be presented in a given lecture, select five to ten subjects for slides and search for this material. We have found that slides made from cross section diagrams and tables of comparative data to be far more valuable than those made from photographs of industrial equipment although the external appearance is of interest. In general preference was given to illustrations similar to those appearing in the textbook used in the course in order that the student might not be burdened with the necessity of copying down extensive descriptions or tabulations. The use of lantern slides produced excellent results and it is our opinion that their use will continue to play

an important part in the development of visual education in a subject which is as involved as general chemistry.

Filmslides were not used extensively. Those available were not prepared for use in chemistry classes and were entirely too elementary. Although filmslides are more convenient than glass lantern slides, they are expensive to prepare and do not permit easy rearrangement. However the glass lantern slide is fragile, heavy and expensive unless purchased in large quantities. We have experimented with a lantern slide made on a safety (cellulose acetate) film base which promises to be light in weight, cheaper and durable.

In the field of motion picture films there is available a very large amount of material which may be secured at little or no cost, since many manufacturing concerns loan films to anyone who is willing to pay the transportation charges. We have found that dependence upon this sort of material involves at least two serious difficulties: (1) it is necessary to make reservations several weeks in advance because the worth while films are busy. In conducting a course in chemistry it is obviously difficult to live up to a rigid schedule in order that a certain film may fit in at the proper time. The uncertainty concerning the arrival of the film on schedule is also a complicating factor which is frequently encountered. (2) All of the commercial films which are now available contain too much advertising. Many of the distributing firms insist that their films must be shown without the elimination of any portions. To comply fully with this request would largely defeat the purposes of visual education, because of the heavy demand of time, and because so much of the film has no value so far as the purposes of chemical education are concerned. Such difficulties as these are perennial if we are to depend on borrowing or renting films.

A method of completely eliminating these difficulties is presented by the outright purchase of the film. The advantages of owning the film are obvious. It is possible to cut out all those scenes which are of a non-chemical nature; the film is always available so its display at the psychological moment presents no difficulties; and if a second showing for review is desired, there is no embarrassment. The great disadvantages of purchasing films come from the cost and the fact that so much of the footage is waste. To compile from

commercial sources a library of motion picture films which would adequately cover a year of general chemistry would obviously require a considerable investment.

In the realm of educational films a much better situation exists. There is a considerable list of science subjects, and these films are arranged for their educational value. Typical scenes from the best sources have been selected and skillfully assembled to give a definite and fairly complete story of the process. In these films a minimum of space is devoted to titles, in order that the picture display may be more complete. It is expected that whatever explanation is necessary will be supplied orally, and to assist in this phase of the presentation each film is accompanied by a Teacher's Guide which supplies all necessary information. This plan permits the chemistry teacher to select a definite topic, to present those portions of the film which fit in with his lecture plan and to do it all without waste of time, and without the necessity of showing time-consuming titles or non-chemical subject matter.

While these educational films show that a great step in advance has been taken, there are still some features of the present situation in which improvement is to be desired. From our experiences the following suggestions are offered. First the list of offerings should be materially extended, because at present there are many of the most important topics in general chemistry which are not represented. This statement applies with particular force to the field of theoretical chemistry, since most of the films now available deal with applied chemistry. It is of course no simple task to devise a film which will adequately represent a fundamental principle of chemical science. Such a film will require long study, patient effort, the most skillful direction which can be obtained and the friendly cooperation of teachers who are willing to help. It is very obvious that the assembling of a series of such films will be an expensive process and no firm can afford to undertake the task until they are assured that the resulting films will be used by a considerable number of teachers. It is probable that developments along this line will be gradual at least so far as the immediate future is concerned.

A second improvement in our present educational films, which would make them of greater value in the teaching of

chemistry requires a thorough editing by an experienced teacher of chemistry. The films which are now available have been prepared for pupils in geography, nature study or general science. The films still contain much material which is not chemical in nature, the showing of which consumes valuable time and detracts from the central thought of a chemical lecture. We need a series of films which have been assembled especially for the use of chemistry students, which will eliminate as much as possible the purely mechanical steps in a process and which will not hesitate to use chemical terms and to emphasize the chemistry involved. When such a collection of films is available for the illustration of chemical industries, and these are accompanied by skillfully devised films on the fundamental theories, then visual education will be in a position to assume a prominent place in the teaching of chemistry.

A third suggestion for the makers of chemistry teaching films is that much greater use be made of animated diagrams. In a chemical process it is of course important to show how the raw material looks when it enters a vat or a machine and then to show its changed appearance or properties after the treatment has been completed. But the chemistry student needs to know how these changes were produced. If a chemical change has resulted he should know what the change is and how it has been brought about. The use of animated diagrams permits him to visualize each step in the process and to get a clear mental picture of the chemistry involved. Some films which accomplish this task admirably are now available but their number should be greatly increased.

In adapting our plan of teaching to the use of motion pictures, it is natural that certain problems should be encountered. Perhaps the first and most fundamental problem involves the question of time. We were convinced by our previous experience that satisfactory educational results could not be obtained unless the films were displayed during the regular lecture periods. But how could time be found for the display of pictures in lectures which were already over-crowded with material? We found the answer in a distinct modification of the lecture plan. The lecturer had formerly been accustomed to make drawings on the blackboard and to use charts for explanatory purposes. These were re-

placed with lantern slides and by this plan better drawings were possible and the time needed to make the drawings was saved. In displaying the motion pictures it was very necessary for the lecturer to make preliminary explanation, but the utmost care was needed to avoid duplication. If the lecturer is thoroughly familiar with the details of the film, it is possible for him to so adjust his explanations as to make clear the lesson of the film and at the same time to avoid needless repetition. This is not an entirely simple task to the lecturer who has been accustomed to making the entire explanation in his own way, but careful planning will solve the problem. When motion pictures are properly presented, it is our opinion that they do not take more time than the old method. We believe a good film will permit the thorough presentation of a topic in less time than is usually consumed without such aids.

It is important in avoiding delays to secure close cooperation between the lecturer and the operator. We found that a complete understanding between these two persons could be secured if the film was studied jointly with a record of the time required for the display of each of the scenes. After determining in this manner how much of the reel could be shown or how much time was required for those scenes which were essential, a rehearsal in the exact form to be used is well worth while. In addition if a code of signals is used, there is little likelihood that a delay will be caused by misunderstanding or even by an emergency change in plan during the progress of the lecture.

In our usual lectures the students are not required to take notes, and some of our best students take no lecture notes at all. In general however the students attempt to take rather full memoranda of all that is said in lecture. The introduction of the methods of visual education produced a new problem in note taking. When lantern slides were being used the side lights in the lecture room were left burning and this permitted the taking of notes. But when motion pictures were shown the entire room was darkened, so note taking was impossible. As a result it was necessary to depend entirely upon memory, and in a surprising number of cases it was evident that very little was remembered.

The most serious difficulty which we encountered in our attempt to teach chemistry by motion pictures came from

the fact that the scenes changed so frequently that the student observer retained no clear cut mental impression of what he had seen. When the picture involved a new process or required the observer to retain a series of definite mental impressions, it was evident that the great majority of the students were failing to respond. This is due largely to the fact that the changes come so rapidly that the mind is unable to grasp the outstanding features of the display. One impression follows another so fast that the memory fails to retain them and only vague and indefinite impressions result. The lecturer must always remember that the film and its story are familiar to him, so that a presentation which may seem to him to be complete and deliberate, may seem to his student to be hurried, incomplete and lacking in clearness.

It is no easy matter to overcome this difficulty, especially when the lecturer desires to embellish his lecture with a liberal showing of attractive pictures and so proceeds at top speed in order to save time. There are at least two plans which may be used successfully in the attempt to impress definitely the important lessons of the film. First, if the projector is stopped at critical points in the display so that the lecturer has time to point out the outstanding facts of the picture, a more lasting mental impression will result. The time required for this process ought not to be great, nor should the interruptions be too frequent. A second and perhaps a better plan for regular use is to employ motion pictures for review purposes after the student has had the opportunity to study the process in detail from his textbook. To carry out this plan it is suggested that the lecture be delivered with lantern slides and other aids of this sort but without motion pictures; then in preparation for his regular recitation the student studies the description from his textbook; at the scheduled hour for his recitation his instructor goes over the principles of the process and the student has an opportunity for asking questions on points which may not be perfectly clear to him. After these repeated contacts it may be assumed that he is somewhat familiar with the process. If at the next lecture the first few minutes of the time is alloted to the display of the motion picture of this same process, it is certain that the educational value of the film will be much greater than could be ex-

pected if the picture is shown without thorough previous preparation.

At the inception of our experiment in the use of visual aids no statement was made to the class calling their attention to this new feature. The displays were given as a regular part of the lecture work, and no attempt was made to stress the educational value of the pictures. As the weeks went by it became evident that the students were coming to regard these pictures as a pleasant relief from the routine of chemical lectures, but that they were not making any definite effort to learn chemistry from the pictures. This we have attributed largely to the fact that in the minds of the students a movie is an entertainment whose value is to be measured by the pleasure it affords. As a consequence the educational value of our pictures was largely missed. To counteract this tendency the instructors were urged to ask questions upon the pictures and in the formal written tests some stress was placed upon this material. It is evident that if visual education is to become a potent factor in teaching chemistry those directing the work must be alive to the tendency to regard movies as entertainment only. This is not a difficult matter if its early symptoms are detected and steps taken to establish the educational importance of the films.

The most difficult task in connection with an experiment of this type is the interpretation of the results. It is especially difficult in the present instance to draw any very definite conclusions from the experience of this one semester's work. On the side of what might be called the intangible results, it was quite evident to the observers that visual education was popular with the students. They welcomed the pictures eagerly, showed keen interest in their display and upon at least one occasion they remained after the dismissal bell was rung even at the risk of being late to the next hour classes. It was evident also from the questions asked that the pictures aroused interest in the chemical processes and made them much more real than they could have been otherwise. We regard this as an important point, because so frequently students at this stage fail to establish any connection at all between the discussions in the chemistry class rooms and the important commercial and domestic affairs of every day life. If the use of motion pictures will

give to our students a proper perspective of the functions of chemistry in connection with our complicated modern life, then we believe that they will do much to take away the sting of the academic and to establish a notion of the practical and useful.

A study of the tangible results of the semester's work in the form of grades is highly desirable. The group of students selected for this study was just beginning the second semester's work, which is devoted to a study of the metals. The course known as Chemistry 5 includes students in Agriculture (60%) in Home Economics and Premedical Courses (40%). Women composed 25% of the total enrollment, mostly in Home Economics. The total enrollment in the course was 297, and these were divided into two identical lecture sections. Three checks upon the accomplishment of these students were possible (1) with a contemporary class in Engineering (293 students); (2) with a contemporary class of Chemists, Chemical Engineers and Chemistry majors (191 students); and (3) with similar classes of preceding semesters. Of these three groups, the first two had identical previous training so far as college chemistry was concerned; and the classes of previous semesters had identical training except with respect to the systematic use of lantern slides and motion picture films.

TABLE I

FIVE YEAR AVERAGES FOR SECOND SEMESTER

	Number Withdrawn	Av. Final Exam.	Av. Final Grade	Percent Failure	Percent A and B
Chem. 4	22	75.0	80.0	7.3	48.0
Chem. 6	9	78.9	84.1	3.4	59.1
Chem. 5	21	73.9	80.1	6.9	50.1
Chem. 5 1930-31	19	76.6	80.0	6.8	44.4

Table I shows the five year averages of these groups of students. It is to be noted that the educational accomplishments of the Agricultural and Medical students of Chemistry 5 are closely parallel to those of the Engineering students in Chemistry 4, while the Chemists (Chemistry 6) make somewhat better records. Below the line is given the record of the experimental group of last semester with whom we used visual education methods. When the accomplishment of this group is compared with that of the preceding five years we see some improvement in the average

final examination grade but a distinct decline in the per cent of students who win A and B grades.

TABLE II
SECOND SEMESTER 1930-31

	Number Enrolled	Number Withdrawn	Av. Final Exam.	Av. Final Grade	Percent Failure	Percent A and B
Chem. 4	291	16	80.5	81 3	3.3	50.9
Chem. 6	193	14	77.8	80.9	4.5	49.7
Chem. 5	297	19	76.6	80.0	6.8	44.4

In Table II we can compare the accomplishment of students using visual education with others of equal training who did not use these methods. From this table alone it might be concluded that students who are taught by visual education methods are not as successful as those who used other methods. A comparison of Tables I and II indicates that no definite conclusions can be drawn from these data.

TABLE III
COMPARISON OF FINAL EXAMINATION RECORDS
Chemistry 5, June 1931

	Number Enrolled	Average grade per question in Final Examination	Average on Visual Education question
Lecture A	148	7.78	7.28
Lecture B	149	7.55	6.18

Table III shows the results of an attempt to definitely determine the value of visual education so far as this group of students is concerned. Each lecture section had its own final examination, and in each there were two questions which were based specifically on some of the pictures which were shown during the semester. It is to be noted that the average grade upon the answers to these questions is less than the average grade per question received upon the examination as a whole.

We believe that no definite conclusion can be drawn from this experiment regarding the educational value of motion pictures in the teaching of general chemistry. It is probably better to allow each one to draw his own conclusions. There are however several points which should be kept in mind. This is our first experience with systematic visual education methods, and we are fully conscious that we have made mistakes which can be avoided in the future. Furthermore our experience has been far too limited to permit us to pass judgment upon this new form of education. We believe that others may profit from the mistakes which we have made and the disappointments which follow a study

of the semester's achievements. We wish to affirm our faith in the educational value of motion pictures and to express our belief that visual education will furnish a valuable method for the training of the youth of the future. From our experience so far we are satisfied that including motion pictures in chemical lectures will not relieve the lecturer of his responsibilities, but it will require him to adjust himself to a new situation. If this can be done successfully, then we believe that general chemistry will at least become less painful and it may even become more practical and more definitely educational.

A PROJECT FOR BEGINNING COLLEGE BIOLOGY

By Fred R. Cark and Ethel Longino,

Southeastern Teachers College, Oklahoma

We have just completed a project in our beginning course in Biology Two (Animal Biology) that has aroused considerable interest among our students and their friends. It might be of help to others in the teaching profession to briefly outline the nature of this exercise.

The outline given the student to complete consisted of the following points:

1. Draw a map of your home county. Locate on this map these things: Towns and cities; railroads and highways; rivers and lakes; mountains, plains, forests, swamps, etc. Color these features.
2. Choose five typical animals of the county. Draw or take photographs of these animals and include in the report. Describe each animal minutely and in detail.
3. Make a complete list of the animals of the county. Classify each one as to phylum, class, etc. Note whether they are native or introduced, common or rare, and similar points of interest.
4. Write a five hundred word article describing the fauna of your county.
5. Use uniform sized paper for this report. When finished bind all together with a cover into a book form. Hand in at the last class period.

Of course a few students were not interested in this project and handed in inferior reports, but by far the great majority did excellent work, quite worthy of being put on exhibition. Some of them asserted that they spent more time on this part of the course than on the rest and with more profit! One or two of the projects compared favorably to books in size, make up and material contained.

THE "CULTURAL" COURSE IN GENERAL PHYSICS FOR COLLEGES*

BY A. A. KNOWLTON,
Reed College, Portland, Ore.

I am accustomed to tell my students that the beginning of understanding lies in precise definition, and that the test of a satisfactory definition is that it be helpful in the solution of problems. It is needful that I profit by my own instruction since the adjective "cultural" in quotation marks is, to me, of dubious meaning and even of rather ill repute. It suggests that there is some peculiar kind of physics for the students of arts colleges, and there seems to be an implication that it will be valuable for the byproduct, culture, rather than for the physics. I am unable to agree with either the suggestion or the implication.

For the purpose of this paper I shall define a cultural course as one which stimulates the imagination, broadens the interests, promotes habits of clear and sound thinking, and provides the basis for a continuing growth in knowledge and understanding of its field. Nothing less will satisfy me as an ideal for the course in general physics, whether it be a course for arts colleges or for engineering students. I am as unwilling to admit that engineers have no need for culture as I am to concede that students of arts colleges have no need for the particular type of rigorous thinking which physics provides. This does not mean that all courses should be alike. The content of the course and the methods of developing it cannot properly be the same for groups which differ widely in experience, mental ability or maturity. The point which I wish to make is that the study of physics possesses both technical and humanistic values, neither of which need be absent from any course.

Culture is quite obviously a thing to be attained rather than imparted. The distinction is important, for it points to the first requisite of a cultural course. It must, in some way, get under the mental skin of the student. Exposure to cultural influences is a necessary but not a sufficient condition. One may paraphrase Newton's first law of motion and say that every individual remains in whatever state of culture he may chance to occupy except insofar as his own

*A paper read before the New Orleans meeting of the American Association of Physics Teachers.

mental activity changes that condition. This means that any course which is to be cultural must be so constructed as to appeal to the student's sense of values. He must see it as worth while. I think it fair that a student demand of the instructor in any subject such a treatment as will provide early and constantly developing answers to such questions as: What is this all about? How is it related to other subjects? What has it to do with the experiences of daily life, and with the ways in which we think and act? Whether the demand be a fair one or not, it is my experience that the arts college student makes it; and if the answers are not satisfactory, he does not take the course. Since culture cannot be acquired in absentia, it follows that, if the cultural influences of the arts college course are to reach many students, the course must, first of all, be attractive.

Fortunately, it is easy for the instructor in physics to provide satisfactory answers to such questions as I have enumerated. Upon the side of the so-called practical applications, we have always made the necessary connections in abundance. Indeed, I am inclined to believe that we may have somewhat overdone this, and that we have overvalued the description of supposedly familiar applications as a means of stimulating interest and clarifying an understanding of principles. There seem to be many people for whom the steering wheel and the accelerator are the only interesting parts of an automobile, and whose only interest in a radio set is as to the quality of tone. This is, after all, a reasonable attitude. Failure to be interested in the details of mechanism is not an indication of mental incapacity nor of laziness. It is quite likely to be merely a result of growing up with these things as units, without ever having had one's attention called to the fascinating character of the concealed parts. It is a part of the cultural course to broaden the students' interests by removing such blind spots, but it must not be forgotten that, for many students, the interest in practical applications needs to be created or aroused by the instructor.

It is not so generally recognized that the effects of basic physical theories and laws upon ways of thinking are equally practical. Theologians have been quicker to recog-

nize this fact than have scientists. It did not take the church authorities long to discover that the Copernican Theory was full of dynamite and that its acceptance would involve consequences inimical to established order. It was not merely that this theory removed the earth from the center of the universe. It and the methods of its advocates were postulated upon the assumption that the way to find out about things was to look at them rather than to ask what the fathers had said about them. Its most explosive quality lay in this assumption that observation was superior to revelation as a means of arriving at a certain class of truths. The hypothesis underlying the Galilean concept of force, as explicitly stated in Newton's First Law of Motion, was an equally potent ferment. The first law may well be described as the scientific declaration of independence. It asserts that every event in nature is the result of natural causes, so that one who appeals to the supernatural to explain any event talks nonsense.

You may object that these are matters for the philosopher. And perhaps you agree with a philosopher of my acquaintance, who says that physicists are usually very bad philosophers. I think the charge is probably true, but I am somewhat comforted by the realization that most philosophers are equally bad physicists. At any rate, I think it a proper part of a cultural course for the instructor to discuss, with due modesty, the implications of such theories. The spread of scientific knowledge is remaking the world of thought today quite as surely as the technical application of that knowledge is modifying the physical environment, and I do not think that the teacher of physics can properly refuse to play his part in the process.

What of the content of the course? Certainly, if it is to provide a basis for a continuing growth in knowledge and understanding in its field, it must include a solid foundation in the elements of mechanics, including wave motion with its simpler applications in the fields of light and sound. Our most familiar experiences are mechanical in nature, and the average person has a feeling of reality in connection with mechanical actions, which is lacking in other fields. Of course, we know that electricity is no more mysterious than matter, but the student does not. All his

thought images are mechanical, as are most of the explanations by means of which we seek to help him secure an understanding of the more obscure fields. For this reason, it seems to me that great stress should be laid on such mechanical topics as the action of forces, the description of motions, and the concept of energy. The treatment of most other topics may grow naturally out of the energy relations involved.

How much of the new physics should be included? Here opinions will differ widely. My own belief is that the amount should be large and that it should form an integral part of the whole rather than a section by itself. This necessitates the excision of much which has formed a part of the traditional course, and one feels reluctant to part with old friends. Yet it is the new physics about which students need to know for the understanding of their contacts with present day science upon both the technical and cultural side. There is no more stirring and inspiring story to be told concerning the achievements of men than is contained in the record of discoveries made in the field of physics during the period of my own acquaintance with that subject: discoveries to which men in this room have been generous contributors. I consider it an extraordinary privilege, as a teacher, to have the opportunity of telling a part of this story to my classes.

What of the order of treatment? For most engineering students and, doubtless for many others, this problem is one which cannot be dealt with upon its merits. Every subject must be cut or stretched to fit the Procrustean bed of quarters, terms, or semesters. Under such conditions it is difficult to secure the continuity of treatment which makes physics stand out in the mind of the students as a single coherent body of knowledge rather than a series of tenuously related topics. Yet, I am so firmly convinced of the superiority of the unified treatment that I cannot conceive of a returning to the traditional order in my own classes. My faith in the superiority of a unified treatment is based upon the fact that my students come to the end of the year with a better understanding of the subject and with a much greater enthusiasm for it, as shown by the numbers who continue its study, than was the case when I followed the traditional order.

The use of mathematics. Since physics is essentially a quantitative subject, I see no way of avoiding the use of what may be described as the normal amount of mathematics in connection with any course which attempts to present this important aspect of the subject. Nor do I find that the formal mathematics presents any serious difficulty once I have succeeded in getting a student to look upon it as a method of concise statement. The important thing seems to be to emphasize the experimental relations and the physical interpretation, rather than the algebraic manipulations. My most serious difficulties in this line have to do with the fact that for many students, multiplication is a slow and tedious process. Indeed, I have not for some years had a student fail for lack of any mathematical ability other than the ability to do arithmetical computations with ease and reasonable speed. At the present time a young woman, who has never had any training whatever in algebra is doing excellent work in my course, including problems.

Personally, I consider a little trigonometry so helpful and so necessary for the study of such topics as the composition of forces, wave motion, and parts of electricity that I give the necessary minimum in connection with the course itself and think that I save time by doing it. The actual instruction, aside from a single lecture devoted mostly to showing the usefulness of the subject, is given individually in the laboratory as the student has occasion to use the material.

It is unfortunate that so much has been made by others than teachers of physics, of the supposed mathematical difficulties. The real difficulties, as I find them, lie in the number of unfamiliar concepts which must be developed, in the precision of statement required, and in the rigorous character of the thinking involved. Very few students have ever had experience with a subject in which it is so true that "pretty good is usually very bad." Moreover, bad thinking in physics always carries an immediate penalty. In many subjects, one may think loosely without being conscious of his own deficiencies. In physics, he is at once confronted with the fact that he has gone astray.

The laboratory. There is evidence in some quarters of

a demand for a cultural course without laboratory work. Personally, if I ever give a non-laboratory course in general physics, which heaven forbid, it will be for those who expect to specialize in science. The reason for this attitude is that these people already have a background of physical experience due to their interest in such things, while the student whose interests are in other channels is likely to be lacking in such experiences, or at least in consciousness of them. I look upon the laboratory as the most important part of the course, a place for the clarification of ideas. It is easy to let the laboratory work degenerate into what Professor Foley has called "baking cakes by recipes," and I quite agree with his conclusion—"They had better be making mud pies." Making mud pies is a form of self-directed activity, voluntarily undertaken and carried out for the maker's own ends. I think laboratory work ought to partake of these qualities. There are few things which I dislike so much as being compelled to assign a laboratory exercise. It means, after the first week or so, that I have failed to get that student to think of his own needs, and I have no faith that he is likely to profit very greatly by my assignment. The student should come to the laboratory, conscious that he needs to clarify his ideas upon some subject, and choose for himself a subject of study. The instructor can then help him to get the necessary apparatus, suggest readings, and be in general helpful rather than officious. This method will result in considerable confusion and disturb much well-ordered routine. It may frequently fail to produce the sacred weekly report. For a time some students will be rebellious at the instructor's failure to tell them what to do, and a few will never attain enough initiative to pick their own problems, but most of them will presently come to see what it is all about and will prosper accordingly. At times I have tried, I think, every way of handling laboratory reports, which I have heard of. Our present method is to tell students that every report should be a short essay upon the subject under consideration, written in the first person singular, telling what they did, using their results as illustration material and telling what they thought about it. These reports are brought to the instructor in the laboratory and form the basis for a short con-

ference on the subject. The requirements as to accuracy are simply that the results shall seem respectable to the student himself, a requirement which turns out to be rather rigorous. I more frequently have occasion to show a student that his results are really reasonably good and informing, than to criticize them upon the basis of carelessness.

Experiments requiring much technique are either avoided, or, when they seem too important to omit, assistance is given on the more difficult parts. I am aware that this sounds difficult and time consuming. It is, especially in the earlier months of the year. Good laboratory teaching is the most difficult sort of teaching I have ever tried, and I think the most important.

The recitation or conference. This year we are trying a plan of one two-hour conference or study period in place of recitation or quiz sections. Fifteen or twenty students gather in the departmental library. They are told—and finally led to believe—that it is their business to ask questions, that difficulties are to be revealed. If a group needs to have a particular point explained, the instructor takes them to the board for that work. They do problems, read, take part in discussion in groups of three or four, or go into the laboratory to use apparatus as seems necessary. This work is in the hands of my colleague, Dr. O'Day, who is enthusiastic about the results. Again, it is a more exacting method of teaching than the quiz section method which we previously used. Both here and in the laboratory, students are encouraged to confer with one another, to assist each other, and to know what the other fellow is doing. Great emphasis is laid on the essential unity of lectures, laboratory, and conferences.

Our Dean of Women, a brilliant and competent scholar in the field of history, frequently says, "Physics is an exciting subject." I think she is right, and I think that the cultural values of general physics are closely linked with its exciting qualities.

One of the first shells that fell in Shanghai destroyed maps and charts compiled by Dr. George B. Cressey, Syracuse University geologist, who spent seven years and travelled 30,000 miles in Manchuria and 24 of the 28 provinces of China gathering material for a geological survey. The documents were stored in the building of the Commercial Press, one of the first targets of Japanese shells.

LABORATORY STUDIES IN ANIMAL ECOLOGY

By John P. Wessel,

Department of Zoology, Crane Junior College, The Municipal College of The City of Chicago, Chicago, Ill.

Introduction

I have submitted upon request the following set of laboratory directions for the study of Ecology, with the hope that they will suggest to high school and college instructors some practical methods of teaching this important but too frequently neglected phase of biology. They may be especially helpful in cases where field studies are not practical because of their continual conflict with the schedule of the general school curriculum. In this laboratory, where we have the necessary ecological equipment to carry out the experiments and observations described in this paper, encouraging results have been obtained.

About four years ago dissatisfaction was expressed with the ecological studies as presented in the laboratory manuals for the elementary course in college zoology. Ecology was not given any special position with relation to the other zoological sciences, but it was scattered throughout the books, as fragmentary studies, which have little if any value to the student. In the majority of cases, the students did not even recognize these fragments as Ecology. It was decided, therefore, to develop adequate laboratory studies in Ecology for the elementary course in Zoology.

The studies were confined to animal behavior, associations, and biotic succession because of the limited amount of time that could be given to such work, and because of the close inter-relationships between these branches of Ecology. It is not the intention of the writer that all of the experiments in animal behavior be performed, but rather, that the instructor choose at least one from each type. The terraria and acquarium for the studies of associations can also be used for other studies in the course. Well designed terraria and aquaria in the laboratory tend to stimulate interest and thought among the members of the class.

The directions will be presented in the same form in which they are used in the laboratory.

Ecology

Ecology is the study of the relation of animals to their environment. In a broad sense, ecology is scientific natural history. We shall first study the reactions of certain typical animals to some environmental factors. This is known as *animal behavior*. Animal behavior plays an important role in the formation of *associations* and *biotic succession*.

Animal Behavior

The following experiments will be demonstrated by the instructor and assistants. Complete records should be made at the time the experiments are performed. A written report of each demonstration is required of the student. The reports should contain the following information:

A. *General Information*
   1. The purpose of the experiment.
   2. The animals used and their recent history.
B. *The Procedure*
C. *Experimental Data*
D. *Conclusions*

The experiment should be as nearly as possible a replica of the natural habitat of the animals, that is, the temperature, light, water, air, and soil, should be approximately the same as those to which the animals are accustomed.

For each experiment a *control experiment* should be set up in order to check the experimental results. The control experiment should contain all of the factors present in the experiment except the factor which is under investigation. If the experimental animals behave differently from the control animals it must be due, then, to the factor present in the experiment which is absent in the control.

a. TAXIS.—Taxis is a reflex action of an entire animal to a stimulus, such as would be furnished by temperature, pressure, currents, etc. Animals moving toward the source of stimulus show a positive reaction; animals moving away exhibit a negative reaction. An animal that responds to a stimulus is either positively or negatively tactic toward it. Such behavior in plants is generally called "tropism."

1. *Heliotaxis:* Heliotaxis is reaction to natural light.

Experiment 1: Test the reactions of frogs, crayfish, land isopods, grasshoppers, fruit flies, spiders, planarians, etc., to light. Use the galvanized iron *heliotaxis pans,* Figure 1. The amount of light admitted to the pans may be regu-

lated by adjusting the width of the slit in the experimental pan. What type of control should be used? Set up a control.

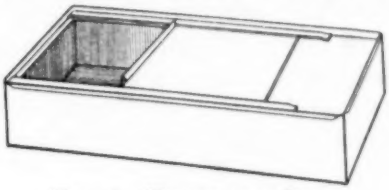


FIG. 1—HELIOTAXIS PAN

Experiment 2: Place a mixed culture of cyclops, daphnia, fresh-water shrimp, and water isopods into each of four tall glass cylinders. Other similar animals may be used. Cover one with black paper to exclude all light. Cover another to exclude light except at the top. Leave the bottom half of another exposed to light; and the other entirely exposed to light. Allow the cylinders to stand for an hour taking observations at ten minute intervals. How do you account for the observed distribution?

2. *Rheotaxis:* Rheotaxis is reaction to water currents.

Experiment 3: Induce a circular current with a glass rod or hand, in a large pan containing planarians or water isopods. Use "conditioned water." Stir until the animals are aggregated in the center of the pan. Set up a control. Do they head up or down stream? Moving against the current is a positive reaction. Are the planarians positively or negatively rheotactic?

3. *Thigmotaxis:* Thigmotaxis is reaction to contact.

Experiment 4: Introduce six or eight land isopods, or planarians, into a large petri dish half of which contains loosely laid thin sheets of mica. Set up a control. Do the animals tend to come to rest when in contact with the mica? In which half are most of the animals?

4. *Thermotaxis:* Thermotaxis is reaction to temperature.

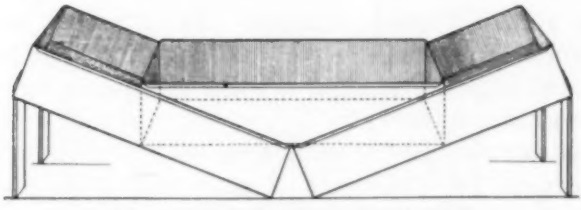


FIG. 2—THERMOTAXIS APPARATUS

Experiment 5: Place a few aquatic animals in the middle tray of the *thermotaxis apparatus*, Figure 2. Allow cold water to circulate through one of the end trays and hot water through the other. Record the temperature at both ends of the middle tray. Set up a suitable control. How do you account for the observed distribution of the animals?

5. *Galvanotaxis:* Galvanotaxis is reaction to the galvanic current.

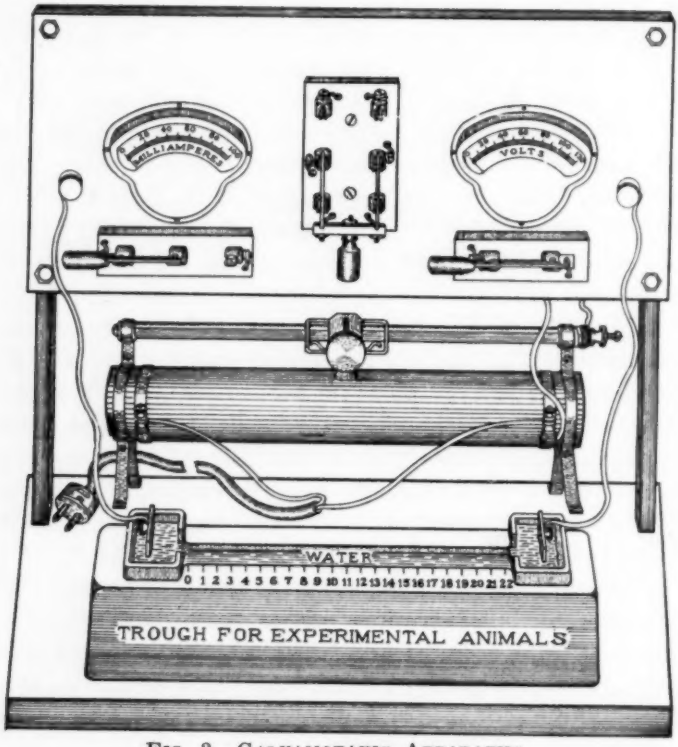


FIG. 3—GALVANOTAXIS APPARATUS

Experiment 6: Use the *galvanotaxis apparatus*, Figure 3. Add a few particles of sodium chloride. Why? Test daphnia (50-100 volts), crayfish (14-20 volts), planaria (10-25 volts), and small fish (14-20 volts). What happens in the case of planaria, and are the results in agreement with the gradient theory?

6. *Hydrotaxis:* Hydrotaxis is reaction to moisture.

Experiment 7: Place soil or sand into a circular pan. Soak one-third of the soil or sand with water; dampen one-

third with water; the remaining one-third to be left dry. Introduce some land isopods or earthworms and cover to exclude light. Set up a control. How do you account for the observed distribution?

7. *Chemotaxis:* Chemotaxis is reaction to chemicals.

Experiment 8: Place a few planaria in a rectangular tray or aquarium and introduce a small piece of fresh beef or liver at one end. Set up a control. How do you account for the observed distribution of the animals?

b. THE MECHANISM RESPONSIBLE FOR TACTIC BEHAVIOR IN SOME ANIMALS.—The nerve reflex is a forced behavior in which sense organs, nerves, and muscles function. The nerve endings in the skin can be stimulated by applying certain chemicals to the skin. The chemical in this case is the stimulus. A stimulus induces a flow of energy through the nervous system, which is finally transmitted to the muscles, causing the muscles to contract. The muscles are said to be innervated by the nerves. The action of the muscles brought about in this manner enables the animal to automatically produce a positive or negative chemotactic reaction.

Experiment 9: The Wiping Reflex.—Pith a frog in the brain only. Bend one end of a wire in the form of a hook. Insert the hook through the tip of the lower jaw of the frog and suspend it to a ring stand. Keep the skin moist. Dip a piece of filter paper about one-eighth inch square into dilute acetic acid or any weak acid and apply it to the skin

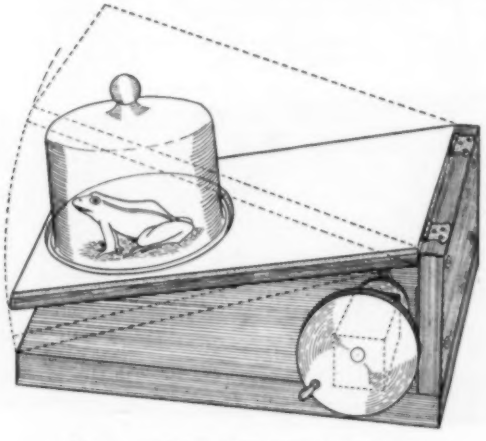


FIG. 4—EYE REFLEX APPARATUS

of the abdomen of the frog. Use forceps in handling the filter paper. How do you account for the wiping reaction?

Experiment 10: The Eye Reflex.—Place a frog in the *eye reflex apparatus*, Figure 4. Now cause the platform to tilt slowly by turning the handle. What happens? Explain.

Experiment 11: The Eye Reflex and Semi-Circular Canal Experiment.—Use an old phonograph. Place a bell jar over the revolving disc so that it will not rotate with the disc. Now place a frog on the disc and allow it to rotate slowly. How does this reflex action differ from the one in experiment 10? Allow the disc to rotate for three or four minutes. What happens after the disc comes to rest? Explain.

Associations

We shall define "associations" as gatherings of flora and fauna produced solely by external factors, such as, temperature, humidity, light, water, soil and foods.

a. XERIC ASSOCIATION.—Observe the terrarium described as a "Xeric Association; a Replica of a New Mexican Desert." Does this association normally have high, intermediate or low temperature? Does a dry, intermediate, or wet condition prevail here? Are the flora and fauna well adapted to their environment, and if so, why? Would you expect to find frogs in this association, and if not, why? Why is the lizard excellently adapted to live in this association?

b. HYDRIC ASSOCIATION.—Observe the aquarium described as a "Hydric Association; a Replica of a Pond in the Chicago Area." List the environmental factors present

Xeric Association—A Replica of a New Mexican Desert

in this association that enable such animals as daphnia, cyclops, hydra, and fish to live in it. What do these animals normally feed on and are any of these foods present?

HYDRIC ASSOCIATION—A REPLICA OF A POND IN THE CHICAGO AREA

MESIC ASSOCIATION—A REPLICA OF A WOODLANDS IN THE CHICAGO AREA

c. MESIC ASSOCIATION.—Observe the terrarium described as a "Mesic Association; a Replica of a Woodlands in the Chicago Area." Note the tree frogs and toads. Why are these animals present in this association? What other animals normally inhabit this association and why? What are some of the animals in this association that are used as food by the frogs and toads? Are any such animals present?

d. HYDRO-MESIC ASSOCIATION.—Observe the terrarium described as a "Hydro-Mesic Association; a Replica of a Swamp in the Chicago Area." Would you expect to find a larger variety of forms in this association than in the preceding associations? Explain. Are there any animals present in this association that require both the mesic and hydric conditions? Explain.

HYDRO-MESIC ASSOCIATION—A REPLICA OF A SWAMP IN THE CHICAGO AREA

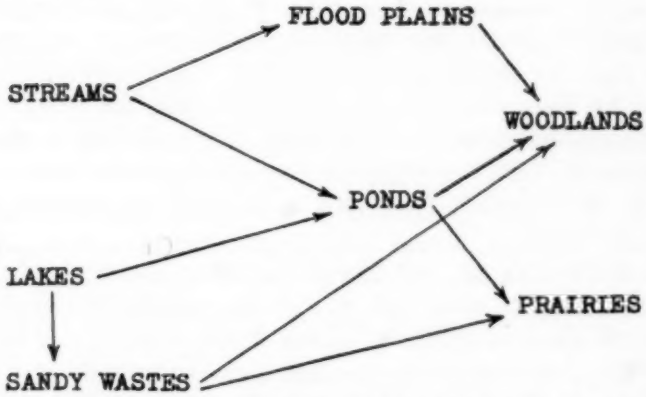
BIOTIC SUCCESSION

Areas containing comparatively meagre quantities of biotic life are usually very dry or very wet. The tendency of succession is usually to establish a climax association which is living in soil of an intermediate wetness. A mesic association, then, is a *climax association,* however, local climate and soil conditions may indefinitely prevent an association from reaching the mesic stage. The acid soil of a bog and the climate of the arctic regions are examples of such limiting conditions.

a. INFLUENCE OF TOPOGRAPHICAL AND FLORAL SUCCESSION UPON ANIMAL SUCCESSION.—The Indiana Shore of Lake Michigan has been gradually receding. For this reason there can be seen all stages in succession on the bare areas left behind on the shores. A study of the stages in succession from a sandy beach to a climax forest has shown that animals will replace existing ones when succession occurs. This was studied on the tiger beetles of the genus *Cicendela,* by Shelford. Cicendela are carnivorous ground beetles of variegated colors. Living in moist sand on the lake margin was *Cicendela cuprascens.* This moist sand, with the further receding of the lake, becomes dry and is then colonized by young cottonwoods, and *C. cuprascens* is replaced by *C. lepida.* Grass and young pine seedlings gradually creep in among the old cottonwoods and here we find that *C. formosa* has replaced *C. lepida.* The pines succeed the cottonwoods and in this dominant pine community, *C. scutellaris* replaces *C. formosa.*

C. scutellaris persists into the next stage in succession, the black oak community, but it becomes gradually scarcer until in the climax association of beach and maple it is entirely absent. Here we have seen the transformation (succession) of a portion of Lake Michigan (hydric association) to a sand-dunes (Xeric association), and then finally to a beach and maple forest (mesic association), and as an integral part of this succession a succession of part of its animal life.

b. GENERAL TREND OF ECOLOGICAL SUCCESSION.—However, hydric associations are usually transformed directly into mesic associations. The Indiana ponds near Hammond, Indiana, Wolf Lake, Illinois, and Lake Calumet, Illinois, are splendid examples of this. These ponds and lakes are being succeeded by prairies and woodlands. The general trend of succession is illustrated in the following diagram.



c. ECOLOGICAL SUCCESSION IN HAY INFUSIONS.

Experiment 12: Animals frequently play an important role in changing their own "environment" to the extent that they no longer can survive, but at the same time produce the necessary environmental changes which favor the occupation of the habitat by other forms. Such ecological succession may be easily studied experimentally in the laboratory by making a hay infusion in water and leaving it exposed to the air for several weeks. Samples of the hay infusion should be analyzed by the student once or twice a month for three months and a record kept of the sequence

in which the forms appear. The *characteristic* form is the one present in greatest numbers. Because of the large amount of decaying vegetation, *Bacteria* are the first characteristic forms to appear. According to Woodruff the first characteristic protozoa to appear are usually minute flagellated forms known as *Monads*. Some of the Monads absorb the products of organic disintegration brought about by the Bacteria while others injest the Bacteria themselves. The Monads are followed by *Colpoda*, a small ciliate, which feed upon the Bacteria. The hypotrichous ciliates, such as *Stylonychia*, succeed Colpoda. The toxic materials excreted by the hypotrichous ciliates retard their rates of growth and reproduction. Although, hypotrich excretions are injurious to hypotrichs, they stimulate the growth and reproduction of *Paramecia*. Paramecia, feeding upon the Bacteria and Colpoda, soon become the characteristic form. The accumulation of toxic materials excreted by Paramecia at first causes an increase in their rates of growth and reproduction and then with increased concentrations of toxic materials they are finally destroyed. The "conditioning" of the water by Paramecia, however, is favorable for the growth and reproduction of *Vorticella*. The Vorticella are succeeded by *Amoeba*. This ecological succession is due in part to the supply of available food and in part to accumulation of toxic material.

d. THE CYCLE OF LIFE IN HAY INFUSIONS.—It is interesting to note that this biotic succession represents a typical cycle of life, that is, the *saprophytic forms* are replaced by *herbivorous forms*, and these in turn by *carnivorous forms*. Forms that feed upon dead material are termed saprophytic; those that feed on plants are said to be herbivorous; while those that feed upon animals are said to be carnivorous. List the saprophytic, herbivorous, and carnivorous forms present during the ecological succession in the hay infusion.

Review Questions

Why is a control necessary in performing an experiment? Define: animal behavior, taxis, tropism, rheotaxis, thermotaxis, and reflex action. Describe the mechanism responsible for tactic behavior in the higher forms. What are some of the inter-relationships between animal be-

havior and the formation of associations? Are associations permanent conditions or do they undergo changes? What is the general trend of ecological succession? Describe a hay infusion from the standpoint of ecological succession. What is a dominant animal? Characteristic animal?

ACKNOWLEDGMENT

The writer gratefully acknowledges his indebtedness to Dr. Warder C. Allee, Mr. Harry Andrews, Dr. Joseph Morrison, and Dr. Jesse Schuett for helpful suggestions; and to the General Biological Supply House, Chicago, Illinois, for permitting reproduction of photographs and drawings.

NEW METHOD FOR DECIMAL POINT ON THE SLIDE RULE

BY F. H. WADE, *Lewis Institute, Chicago*

It is a simple matter to keep track of the decimal point on the slide rule. All that is necessary is to count the integers. Then the rule is, for multiplication, ADD, and for division SUBTRACT. Due to the fact that the slide rule scale is based on logarithms and has no beginning or end, there is one precaution to be taken. When the stick projects to the right, call the integers in the multiplier or divisor, as the case may be, ONE LESS than they really are.

Example. 2.65×532. The sum of the integers gives $1+3=4$ and the product is thus 1410.

Example. $175 \times .004$. The first factor has three integers. The second factor has negative 2, but the stick projects to the right so call it one less or negative 3. Then in the product there will be 3+negative 3=none, which gives the answer 0.7.

Example. $660 \div 25$. The divisor has two integers, but since the stick projects to the right call it one. For the quotient we have 3—1=2, giving 26.4.

Example. $34.2 \div .06$. Here we have 2—negative 1 giving 3 for the quotient which is 570.

Example. $565 \div .00005$. The divisor has negative 4 but stick projects to the right, so call it one less, or negative 5. So for the quotient subtract negative 5 from 3 giving 8 integers, and the answer is 11,300,000.

Example. Continued multiplication and division presents no difficulty. The process is the same, and there are no exceptions. Watch which way the stick projects and keep track of the integers mentally, step by step.

$$\frac{83 \times 3.6 \times .0051}{25 \times 1800}$$

Step	*On the rule, C & D*	*To be said mentally*
1.	Right index on 83, D scale	Two
2.	Glass to 3.6	plus one is three
3.	25 to glass	less one is two
4.	Glass to .0051	and neg 3 is neg 1
5.	1800 to glass	and neg 3 is neg 4 in
6.	Under index read .0000338	the answer.

A HOMEMADE OPTICAL LEVER

By Ellis Smith

Muskingum College, New Concord, Ohio

The instrument here described is an optical lever which may be used without a telescope. It is a fairly reliable instrument for measuring small displacements or dimensions, and may be made in any work shop.

The optical lever, itself, is made from three finishing nails, a small square mirror, and a small half inch board, preferably sawed into the shape of an isosceles triangle. A top view of the instrument, with dimensions, is given in Figure 1.

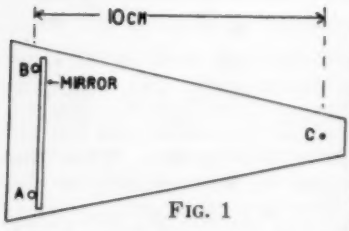


Fig. 1

The finishing nails, a, b, and c, are to be driven about half way through the board. Nail c should be cut off even with the top of the board, but the two back nails, a, and b, are to be left with heads extending above the board.

Using India ink, rule a line across the mirror parallel to two of the sides, then fasten the mirror, with the cross hair in a horizontal position, to the two protruding nail heads, a, and b, with a little sealing wax. The mirror may be tilted to any desired angle before the wax hardens. Results may be obtained when the point of vision is localized as shown schematically in Figure 2.

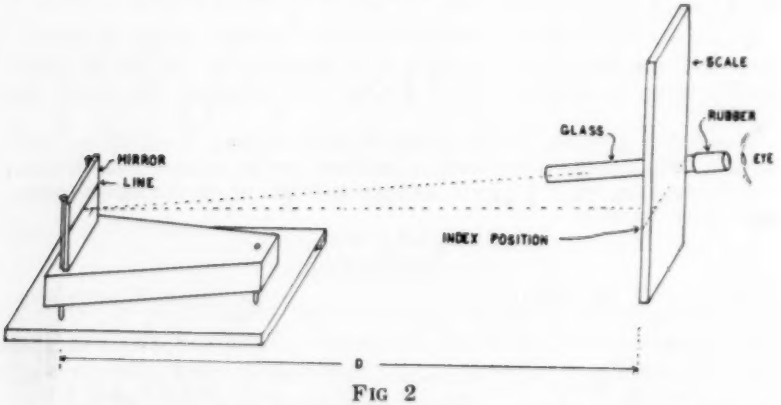


Fig 2

A foot length of fourth inch glass tubing, one end of

which is protected by a piece of rubber tubing, is clamped, with the protected end next to the eye, beside the vertical scale, which may be a meter or yard stick. The tube is so clamped as to be trained on the mirror. This not only helps to localize the line of vision, but almost eliminates parallex.

The index is made by soldering a short black wire across the front of a small thumb screw clamp. Other devices may be used, such as a rectangular piece of white cardboard with a horizontal black line. The scale is read at the top or bottom of the cardboard.

With the apparatus in the position shown in Figure 2, adjust the height of the index until the line on the mirror and the index appear to coincide when viewed through the glass tube. Read the position of the index on the scale. This is the zero reading, and is to be taken with all three feet of the optical lever resting on the plate glass. Slip the object whose thickness is to be measured, under the front foot of the optical lever, and proceed as before to find the new scale reading.

The thickness of the object being measured may be computed from the simple proposition:

$$x:u=\frac{s}{2}:d \quad \text{or,} \quad x=\frac{us}{2d}$$

where x is the thickness, s the shift in scale readings, u the length of the turning arm of the optical lever (10 cm., in the apparatus described), and d the distance from the turning axis to the scale.

If this piece of apparatus is used in a school laboratory, it is well to allow the pupil to take scale readings by a second method, in which the point of vision is not localized. A few inches of black thread may be used as the index. Sight across the thread and slide it along the scale until the thread and its image are in line. Then take the corresponding scale reading.

When measuring objects of equal thickness, it is found that the scale shift, by this method, is just half the scale shift when the point of vision is localized. When this method is used, the thickness of the object measured is computed from the proportion of similar triangles.

$$x:u=s:d \quad \text{or,} \quad x=\frac{us}{d}$$

Illustrative data are given in the table below:

	Micrometre	Optical lever	
Object	gauge	First Method	Second Method
No. 1	0.28 mm.	0.30 mm.	0.30 mm.
No. 2	0.30 mm.	0.32 mm.	0.33 mm.
No. 3	0.23 mm.	0.25 mm.	0.25 mm.

It may be readily seen that this double method of using the optical lever provides an effective method of teaching the properties of a reflected ray of light.

COMPASS GEOMETRY*

BY WALTER H. CARNAHAN
Shortridge High School, Indianapolis

In ancient Egypt, geometry was a tool of the engineers and craftsmen. They were interested in rules for finding area and volume, methods for constructing angles of various sizes, ways of dividing arcs and lengths, and in other mechanical applications of a limited number of the facts with which geometry deals. So long as this situation prevailed, the craftsman might devise any instrument that would accomplish the result he wished to attain. The Harpedonaptae used a knotted rope for constructing a right angle, and no doubt other primitive devices aided the Egyptian geometer.

But when geometry went over into Greece from Egypt it passed (not, however, without a contest) from the possession of the mechanic to the control of the scholar. The Greek geometer was interested but little in the practical applications of the science but very much in its logical development. For example, trisection of the angle might have not the slightest practical importance, but it became a very challenging problem to the scientist interested in the extension of the mastery of the subject to the utmost limits. The fact that the problem stubbornly resisted efforts to find a solution made it all the more interesting. Geometers vied with each other in contributing new steps that led in the direction of a complete solution of the problem. In their extremity they invented ingenious machines for constructing the trisector and pridefully announced

*Read at the Mathematics Section Meeting of The Central Association of Science and Mathematics Teachers, November 1931.

that they had made real contributions to geometrical progress. And so with the duplication of the cube and the quadrature of the circle they multiplied machines and considered themselves benefactors of the science.

But in the pride of their achievements they must have had the feeling that they were more mechanics than scientists. They were openly and vigorously accused of degrading a noble science to the level of mechanics. At last, so it is said, the situation was laid before Plato to make suggestions that would lift the subject once more onto the high plane of logic and science. Plato believed, as many are still struggling to maintain, that geometry is a subject whose chief benefit lies in the mental training it provides, and that the fewer tools employed in its constructions, the more nearly it would come to conferring the maximum of its peculiar benefits upon those who gave attention to it. Looking into the problems of elementary geometry, solved and unsolved, it was clear to the great logician that they were expressible in terms of straight lines and circles. Hence it seemed reasonable that their solutions should involve only such figures. One might make a construction with a trisectrix, a quadratrix, the compasses or a straight edge, but the various tools were not equally useful in training minds, whatever might be said of their effectiveness in performing the required mechanical operation. Without hesitation, Plato pronounced in favor of limiting the tools of geometry to compasses and straight edge. That decision was an event of far reaching importance in the history of geometry. It took the subject from the realm of mechanics and preserved it for those who love it for its beauty, and value it for its mental discipline. For more than twenty centuries mathematicians have accepted the limitations which Plato imposed and have done so with no protest.

But there may yet come a time when Plato will be criticized, not because he allowed too few tools, but because he allowed too many. It is not wholly from curiosity that some mathematicians have recently turned their attention to attempts to make all constructions with compasses alone, leaving out of use one of the two tools employed since the time of Plato. The compasses are exceedingly simple. Essentially they consist of two points whose distance apart

is fixed during any particular operation. But, whatever the appearance may be, the straight edge is not so simple, at least when one comes to define and make one. Suppose it be defined as an object one of whose edges is a straight line; how can it be constructed? The one employed by a geometer today was made from another which was copied after another which was a duplicate of yet another, and so ad infinitum. How was the first one obtained? Did Plato who specifically favored the use of the straight edge know how to make one? Did Euclid? It is well known that Euclid eliminated from his Elements every postulate possible. The fact that his first and second postulates have to do with the drawing of a straight line would seem to indicate positively that he recognized the impossibility of actually making one. It is perhaps true that no mathematician for 2000 years after Euclid recognized so clearly as the great Greek the fundamental difficulty involved. Here was a science that dealt continually and necessarily with an element which the scientist knew not how to make and which employed a tool that had no existence.

The carpenter gets a straight line by sighting along the edge he is planing to see where the high and low points are. But this merely tests whether he has or has not a straight line and is of no help whatever in getting one. Shall we say then it is impossible to construct a straight line? Fortunately we are not driven to that extremity, for the construction of the straight line has been achieved within comparatively recent times.

Not until 1853 had any man, so far as we know, ever made this construction. In that year Sarraut invented a machine that would make a straight line. However, his work was not widely known and was soon forgotten. In 1864 Peaucellier devised his linkage for constructing a straight line and published his solution of the problem in Nouvelles Annales in 1873. Since that time there have been other linkages devised for constructing a straight line, and Kemp has written a book on "How to Draw a Straight Line." There is then the possibility of substituting for the straight edge one of these linkages for converting circular into rectilinear motion.

There is another alternative, suggested above, namely,

to discard all tools for constructing a straight line and make all constructions with the compasses alone. One has the feeling that Plato, had he known that the compasses is the only tool actually necessary, would have recommended the elimination of all others. This would certainly have been a step in the direction of freeing the science more completely of mechanical connections and placing it in the realm of the purely intellectual. Thus we would have been freed from the difficulty which Euclid so clearly recognized but was unable to meet, which was so consistently avoided by later mathematicians for two thousand years and which was met at last by invention of machines which Plato and Euclid would almost certainly have rejected.

If it be admitted that the straight edge has no existence in fact except it be constructed by a machine which geometers do not recognize, we are necessarily limited to the compasses as our only tool in making constructions, and solutions of many problems in geometry are quite different from those ordinarily given.

The first mathematician to work out a systematic treatment of the problems of geometry with the compasses as his only tool was George Mohr of Denmark who in 1672 published simultaneously in Danish and Dutch a book of 78 compass constructions under the title of Euclides Danicus. This work gives many fundamental constructions found in later works more widely known. Mohr's work attracted little attention and seems to have been completely forgotten until a very recent date when it was reissued in fascimile with a German translation.

A century later Lorenzo Mascheroni, a professor of mathematics in the University of Pavia in Italy, advocated the exclusive use of the compasses by engineers as being a more accurate tool than the straight edge. He made an extended study of construction problems and proved that all constructions possible with straight edge and compasses can be done with the compasses alone. Mohr was entitled to announce the same theorem since he had made the construction on which Mascheroni based his proof, but seems not to have formally stated it. Mascheroni published his work, Geometria del Compasso, in 1797. The next year a French Translation appeared, and since that time the subject has attracted considerable interest. Very little atten-

tion has been given to the subject in England and America, however, and one interested in it must do his research in Danish, Italian, French and German. It was Napoleon who was largely responsible for directing attention to Mascheroni's work. When he conquered Italy, he made the acquaintance of Mascheroni and took a deep interest in the work of the Italian. On returning to France Napoleon gave to his acquaintances a number of Mascheroni's problems which have since been called the problems of Napoleon.

For the last two and a half centuries contributions to the geometry of the compass have been accumulating until all the common constructions of Euclidean geometry have been made without the use of the straight edge. De Lanascol of France has written exhaustively on the subject and in his Geometrie du Compas published in 1925 has presented a complete treatment of the new geometry.

It cannot be urged that the straight edge be rejected in making geometric constructions for to do so would add materially to the difficulty of many constructions, but it is convenience alone and not necessity that justifies its retention.

Proof that all constructions possible with the straight edge and compasses can be made with the compasses alone depends upon summary of all possible fundamental relations between straight lines and circles and showing how to make compass constructions of these relations.

All constructions involve the determination of points. If the construction is that of making a single circle it involves making all points of the locus. Other constructions have to do with location of intersection points. These are determined in three ways: (1) The points of intersection of two circles. (2) The point of intersection of two straight lines. (3) The points of intersection of a straight line and a circle. The first named construction does not involve a straight line in any way and is scarcely to be considered a problem. Solutions of the other two problems are given below. With these constructions done, solution of all construction problems becomes merely an application of these. However, special methods often shorten the work. It is with these special methods that compass geometry concerns itself.

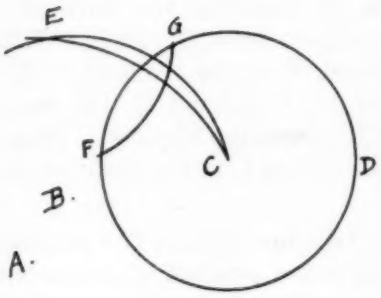


Fig. 1

1. To construct the points of intersection of a straight line and a circle. (Fig. 1).

Construction. Let AB be the given line and C (CD) the given circle. Describe circles A (AC) and B (BC) intersecting the second time at E. (E is the symmetric of C with regard to AB). Describe circle E (CD) intersecting C (CD) at F and G. Then F and G are the points of intersection of the line AB and the circle C (CD).

Proof. AB is the perpendicular bisector of CE, and, since F and G are each equidistant from C and E, they lie on AB.

Remark. When A, B and C are collinear this construction fails. In that case one uses Mascheroni's method for bisecting an arc of C (CD) intercepted by any convenient circle with B as center.

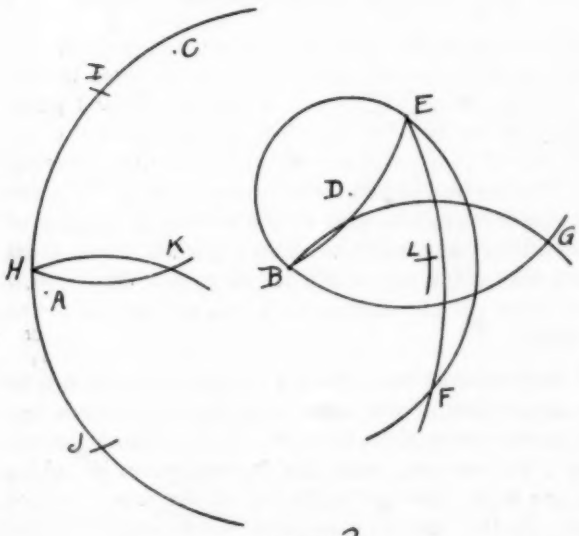


Fig. 2.

2. To construct the point of intersection of two straight lines. (Fig. 2).

Construction. Let AB and CD be the given lines. Construct E, the symmetric of B with regard to CD. Construct F, the symmet-

ric of E with regard to AB. Construct G, the symmetric of B with regard to EF. We now construct the third proportional to BG and BE. Describe circle B (BG). With any point H on B (BG) as center describe circle H (BE) intersecting B (BG) at I and J. Construct K, the symmetric of H with regard to IJ. Describe circles B (HK) and E (HK) intersecting at L. Then L is the point of intersection of AB and CD.

Proof. HI times HJ equals HK times BH. (The product of two sides of a triangle equals the product of twice the altitude on the third side by the radius of the circumscribed circle). Hence, BG:BE equals BE:BL. Also BE:BL equals EG:EL. Therefore triangles BEL and BEG are similar, and angles EBL and EBG are equal. Hence L lies on BG. But A lies on BG since it is equidistant from E and F, or, L lies on AB. A also lies on CD since CD is the perpendicular bisector of BE. Therefore L is the intersection point of AB and CD.

USING THE AIR PUMP IN THE CARTESIAN DIVER DEMONSTRATION

By H. F. Cope, *Medford High School, Medford, Oregon.*

Teachers, if you are looking for something different in making this demonstration, just try either the air pump or the filter pump in connection with the hydrometer jar and diver. A tall bell jar and pump plate are desirable. If the bell jar does not accommodate the hydrometer jar, take one of your resonance tubes, with rubber stopper in one end of it. Fill the jar or tube with water, placing in it the diver that is just heavy enough to sink to the bottom of the jar or tube. Place under bell jar and begin to remove the air. In a short time the diver will rise to the top of the jar or tube. Why? Now stop the pump and allow the air to come back into the bell jar. The diver will sink. Why?

This is a great improvement over the old method and you will be able to show the application of the same principles with much less exertion and with considerably more interest. Even without the tall bell jar and pump plate one may make the demonstration by taking the air line from the pump directly to the top of the tube in which the diver is placed. In this case fit a one-hole rubber stopper to the top of the tube and attach the air line by using a short piece of glass tubing.

NATURE COUNSELOR PREPARATION IN RELATION TO THE STATUS OF NATURE STUDY IN CAMPS

By Stanley Mulaik,
Cornell University, Ithaca, N. Y.

The growth of the summer camp movement has been very rapid in the last decade, and camp directors are finding it harder each season to secure properly trained nature counselors who can conduct successful nature study programs. In despair, some camp directors have completely discarded nature study from their programs.

At the instigation of Dr. E. L. Palmer, a study of the nature counselor preparation in relation to the status of nature study in camps was conducted during the winter of 1930-31. Details of the procedure of this study will not be given here for want of space. It may be said that of the seven hundred camp directors in thirty-six states who were canvassed with a card questionnaire, 281 or 40.4 per cent replied. This per cent was derived after deduction had been made from several questionnaires returned for incorrect or incomplete address.

From the card questionnaire returned, a list of counselors' names and addresses was secured. This list together with some from other sources brought the list of nature counselors up to 291. Thirty-eight per cent or 108 of these counselors supplied information regarding their training, experience and facts concerning content and methods used in their camp nature programs.

Two months after sending the card questionnaire to the camp directors, a longer mimeographed questionnaire was sent to them. Methods of selecting nature counselors, preparation desired, nature programs featured, and other information about the camp was requested and secured. These will be briefly taken up in this paper.

Camp directors submitted numerous comments and suggestions concerning camp nature study which were enlightening. Many of them criticised nature counselors because they attempted to review their college zoology, botany and other science courses in the name of nature study. Criticisms concerning the knowledge of much content with little or no methods in nature or science teaching as compared with a minimum of content and

some knowledge of methods in nature education were numerous.

Data were secured from nature counselors concerning their training and experience indicating fitness for work as nature counselors. Some data on nature counselor training were sought from camp directors, but returns were so meager that they were discarded as being unrepresentative.

A comparison of nature counselors in those camps reporting nature study as the most successfully handled with those counselors in camps where nature study was the poorest handled activity reveals some differences.

The average number of years of post high school work for all counselors involved in this study is 4.0 years. Successful counselors had 3.9 years while unsuccessful counselors had 4.4 years. Since this .4 of a year beyond that required for a college degree was spent on post graduate work in some more or less specialized technical field, it may be said that this additional work may have produced in the counselor a tendency to over emphasize the technical material when dealing with campers. There were 92 degrees reported for the 108 counselors. This is perhaps much higher than one would usually find it to be elsewhere among leaders who deal with children of the average age of 12.2 years as shown by this study.

Biology and botany were the most common majors studied, each being reported by eleven counselors. Chemistry was next with ten reporting it. There were 32 counselors, 36.7 per cent of those reporting, who majored in the biological field, while the remainder were well scattered among sixteen other fields. Only four had a major in nature education. It may be that the offerings in nature education are not extensive enough to enable more people to enter this field rather than into the general science field.

The credit hours for these majors show that botany was the first with an average of 5 credit hours reported by successful counselors and 15.8 credit hours reported by unsuccessful counselors. The same relative number of hours was reported in chemistry, zoology, physics, geology, entomology and astronomy. In physiology,

ornithology, nature study and forestry this order is reversed. These four are considered of more importance in camp nature study than are the specific subjects enumerated above.

It was further found that the average for all counselors was 32.2 credit hours in all of the above subjects. The average for successful counselors was 23.3 credit hours, whereas for unsuccessful counselors the average was 38.4 credit hours. There were 84 counselors who reported having taken no courses in methods of science teaching. Sixty per cent of the successful and 80 per cent of the unsuccessful reported having had no such courses. The average for successful counselors was 2.95 credit hours in methods of science teaching which is 111 per cent more than the average of 1.4 credit hours reported for unsuccessful counselors.

Reference to our data shows that whereas the unsuccessful counselors had 68.4 per cent more credit hours in content material, they had 55 per cent less training in methods in science teaching than did the successful counselors. To know content is not necessarily to know how to present it to campers. Method courses in biology teaching and in nature study were by far the most common reported.

Returns were made by counselors concerning their training in the fields of education such as educational psychology, psychology of adolescense, teaching of science, introduction to teaching, and teaching of nature study. It is found that the average for all counselors was 8.5 credit hours, and for successful counselors it was 8.25 credit hours. This is 56 per cent more than the 5.3 credit hours for unsuccessful counselors.

Counselors listed in the order of importance to camp work the science subjects studied. When ranking in the order of total number of points for all rankings, botany was first with nature study second. However, in the matter of first choices, this order is reversed, and nature study has more than twice as many first choices as does botany. Ornithology is third in the number of points for all choices and third in the number of first choices. These three subjects include approximately 84

per cent of the total of all of the first choices.

Such a large evaluation placed upon botany indicates that counselors present a nature study program which is definitely one sided. Rather than attempting a program which involves practically all of the factors of their environment, they are stressing only certain features of it. This is undoubtedly an outgrowth of their college training which is given in such units as botany, zoology, etc., and few counselors grasped the significance of the interrelation of all of these in the camping situation.

The average number of activities such as field trips, nature stories, nature trails, nature games, terraria, and other nature crafts in which counselors received training was 4.1. The average for successful counselors was 5.4 activities or 70.3 per cent more than the 3.2 activities reported by unsuccessful counselors. These activities serve as tools, and training in the use of them will insure better nature programs.

However, when the data dealing with the use of these activities is studied, it is found that whereas the successful counselors reported having used 5.4 activities, which is the number they had been trained in, the unsuccessful counselors reported using 7.6 activities when they had been trained in only 3.2 of them. One may draw the conclusion that while the successful counselors attempted on an average no more than he had been trained in, and thus remained on more or less familiar ground, the unsuccessful attempted more than twice as many as he had been trained in, and found himself floundering in unfamiliar activities poorly presented to campers.

Few colleges offer training in the use of these nature activities. Efforts to give this much needed work are being made at Western Reserve University, Cleveland, under the direction of Dr. W. G. Vinal, at Cornell University under the direction of Dr. E. L. Palmer, and through such organizations as the Nature Training School conducted by Mr. A. B. Brooks at Oglebay Park, Wheeling, W. Va. It is interesting to note that while there were nine successful counselors who had attended a nature training school or camp, only one of the unsuccessful counselors had done so.

Another important factor in determining the prepara-

tion for success is the experience as campers. It is found that the median of experience as campers is 2.18 years. On the other hand, it was found that the campers in the camps surveyed had a median of 3.08 years camping experience which is 41.5 per cent more than their counselors had. Since the counselors do not have at least as much camping experience as do the campers, they will hardly have learned to adjust themselves to the camping situation as well as the campers have learned to adjust themselves. Nor does the average of .51 years as assistant counselor make up for this difference.

Camps varied considerably in size. The average for all camps in this study was 110 campers, while for private camps it was 84 and for organization camps such as the scouts, and Y. M. C. A. the average was 177 campers. Likewise, the average number of campers per counselor for all camps was 5.6 while in private camps it was 4.3 campers and in organization camps it was 8.8 campers.

It is quite evident from these figures that the campers in private camps have more opportunities for contact with counselors than they have in organization camps, though the result as far as nature education is concerned do not appear as favorable. In a study conducted by Mr. Bernard S. Mason and reported in his *Camping and Education,* and in a survey of nature activities in the Cleveland camps operated under the direction of the Welfare Federation, it was found that the campers considered the waterfront activities as the best liked in camp. This department likewise led in the present study. While 34 per cent of the Cleveland campers chose this department as the best liked, 40 per cent of the campers in Mason's study, 36.5 per cent of the private camp directors, and 29 per cent of the organization camp directors considered it as the best favored activity.

Nature study was selected by 23.6 per cent of the organization camp directors and by 22 per cent of the Cleveland campers. On the other hand this activity was selected by only 11.9 per cent of the private camp directors and by one per cent of the campers in Mason's study. From this it may be said that generally the private camps are less successful in their nature programs than they

are in the waterfront, athletics or riding activities.

Ninety camp directors indicated on their questionnaires the departments which they considered the weakest in camp. Of this number, thirty-four considered nature study the weakest, eight considered dramatics the weakest, eight the crafts, thirty-two said that the department varied, and the remainder were scattered among the other activities. Forty-eight camp directors considered that teaching experience was an asset, twenty thought that it was a liability, and twenty-two thought that it varied with the individual. Practically one-half of the counselors were school teachers at various levels, and it was found that the successful counselors had 39 per cent more teaching experience than did the unsuccessful ones.

Thirty camp directors gave reasons why teaching experience was considered an asset. Eleven of these said that the experienced teacher understands boys and girls better, ten said that they are better prepared to organize and present nature materials. Others said that teaching gave background, it helped if the teach was not too formal and school-like, and that teachers were more practical.

On the other hand, ten camp directors believed that teaching experience was a liability. They considered teachers too formal and school-like in the camping situation. Two considered teachers too bookish, two as too routinized, and six others each gave one reason.

Forty replies were received which listed the camp directors' belief in why nature counselors were the weakest in camp. Twenty-nine or 85 per cent of the 33 replying to this question considered that improper preparation for nature work was the main factor in making unsuccessful counselors. Four believed that it was poor selection of counselors, six gave miscellaneous reasons, two stating that nature men were too effeminate, and one that nature counselors were not normal individuals. It is most interesting to note that whereas the largest number of failures were attributed to lack of preparation, and only three to personality, in another part of the questionnaire a different viewpoint is given. To the request that they rank items important in the selection of coun-

selors we get the following returns. Fifty-nine per cent of the camp directors considered personality most important in the selection of counselors, 29 per cent considered a knowledge of subject matter most important, 4 per cent considered methods of presentation, 3 per cent considered experience in camp, and none considered training in professional education as important.

The question arises as to what value can be attached to the camp director's measure of personality when choosing a counselor. These findings further indicate that a more objective measure for selecting nature counselors is necessary. More emphasis should be placed upon nature education, upon preparation through experience with boys and girls, and in other objective factors as shown elsewhere in this study.

In eighty-one camps nature study was voluntary, and in twenty it was required. There were fifty-five nature counselors who replied that a definite course was outlined for nature study, while forty-four reported that there was no definite course followed. It would appear from the limited training in nature study and in methods for handling the subject that a definite program with more carefully planned objectives should be adopted more universally.

Counselors were requested to rank certain items in nature study in the order of interest to campers. These were listed in the order of first choices as birds, flowers, reptiles, trees, insects, mammals, amphibians, fish, stars, ferns, rocks, fungi, mosses, minerals and grasses. Birds, flowers and reptiles constitute 51.8 per cent of the total of first choices. On the other hand, birds, trees, flowers, and reptiles constitute 52.5 per cent of the total of points for all choices. The first five items listed in the order of total points included 81 per cent of the points. Whether this might be interpreted as indicating a one sided nature program is difficult to say.

Information concerning the procedure in handling nature study was given by eighty counselors. Twenty-eight reported that their work was centered on requiring a minimum of knowledge of nature study before some camp emblem, award, honor, etc., could be granted. This was variously reported as calling for a knowledge of a mini-

mum number of trees, birds, flowers, insects, etc. Apparently the general inducement to the camper was not the nature appreciation but the award. Fifteen reported that their work was centered in the identification of trees, flowers, insects and other nature materials. Here is a possible weakness in the nature study of many camps. Names of these things should not be given for their own sake. They should serve as handles to help the camper identify those things in which his interest has been aroused. These two procedures comprise more than half of the number of procedures given, and both are concerned largely in the naming of things.

The camp offers excellent opportunities for correlating nature study with other activities. On the other hand, thirty-one directors indicated that no effort was being made to carry out such a correlation, twenty-eight stated that it was correlated with hiking and trips, eight with handcrafts, seven with woodcraft, and one each with pioneering, photography, dramatics, and personal hygiene.

It would appear that the many nature pheomena which arise in connection with every activity in camp should produce a more definite tying up of those activities with the nature program. The reports of the camp directors would imply that these relationships are not recognized. Undoubtedly the counselors are not aware of these relationships either, for it would seem that more effort would be made to call attention to them if they were aware that they exist.

Included in the questionnaire sent to the counselors was a list of subjects selected at random dealing largely with the biological field. Counselors were asked to check those subjects which were given a definite place in the nature program. Parasitism was given a place by 72 counselors, and this is 66 per cent of the total group. Of the successful counselors 14 or 70 per cent, and of the unsuccesful counselors 5 or 50 per cent included this item in their program. Pollination, mosses, reproduction, erosion, and chlorophyll were used by more than 50 per cent of the counselors.

Though this list was selected at random, the returns were quite interesting from the nature study standpoint.

The camps included in this survey dealt with children whose median age was 12.2 years. This is the age level of the sixth or seventh grade children. Since 90.2 per cent of the campers were between the ages of 11 and 14 years, to include most of the items in this table in the nature study program is to attempt the presentation of high school science courses to boys and girls too young to grasp the subject.

It is difficult to understand why counselors would attempt to teach mitosis, mutations, chromosomes, hybridization, or some of the others of these items to children of this age. Only four counselors indicated that most of these items had no place in the camp nature program.

The conclusions to be drawn from the findings in methods in science teaching are echoed in the suggestions made by camp directors as to what schools and nature training camps might do to improve their services. The greatest number felt that more training in methods of presentation of nature study should be given to students. A knowledge of how to present nature knowledge through better techniques in stimulating observation, limiting the "teacher" attitude, teaching through stories, and through correlation with other activities is desirable.

A smaller number felt that the counselors should study the needs of campers and their characteristics. About the same number considered that a knowledge of camping and of the outdoors is essential. Eleven directors considered that counselors should know their subject as well as have a deep enthusiasm for nature study.

SUMMARY

In summing up our data we have several outstanding points. Nature study is being handled in camps very largely by people unprepared for this type of work. Nature counselors have considerable training in content in the usual college science courses as indicated by their majors and by the credit hours in the science subjects. Yet content is not the most important need. Successful counselors had only 68% as much training in the science courses as did the unsuccessful counselors. However, the successful counselors had 111% more training in methods of science teaching. Few counselors had training in na-

ture activities which serve as excellent tools in carrying out the camp nature program.

Camp directors considered teaching experience as generally an asset, and it was found that counselors reported as successful had more experience as teachers than the unsuccessful had. It appears that camp directors must use more objective measures in selecting counselors. Though camp directors considered personality as most important in the selection of counselors, very few reported nature counselors weak because of a lack in this quality. There must be other factors entering to make for success. Prospective counselors must secure a background of methods in handling of nature crafts, must know children through study of their habits, and must be well acquainted by experience with camping situations.

The nature study program should center in the camp environment and its unified series of nature phenomena. A program built on a counselor's college botany, zoology or other science course will hardly answer the intense interest and curiosity of the camper. This will arise because the stimulus of the camp environment will prompt it. The inter-relationship of all camp nature rather than a knowledge of names in such fields as flowers, birds, insects, trees, etc., should be the main theme. Those things which arouse the child's curiosity should be stressed and not necessarily what the counselor might think. A carefully worked out course in nature study in the camp will keep in mind the child and his eternal curiosity, and will have in it opportunities for developing skills in handling various nature crafts. Until such a program is presented by properly trained individuals, nature study will remain as one of the unsuccessful activities in many camps.

SOIL FORMED IN 400 YEARS, ERODED AWAY IN ONE

Four hundred years to form an inch of top soil, one year to wash it away, according to a report by H. H. Bennett. With a slope of only eight feet in a hundred, corn-belt topsoil loam washes away in a four-hundredth of the time it takes for its formation. Even with a gentler slope, of four feet in a hundred, seven years suffices for the erosion of the valuable top inch. The plant food removed from fields and pastures by erosion is at least 21 times more than that removed by the crops harvested, the speaker stated.

THE SCIENCE SECTION OF THE STATE TEACHERS' ASSOCIATION

By A. C. MONAHAN,

Formerly U. S. Bureau of Education

Thirty-five States have science sections in their State Teachers Associations and six others, in which district meetings are held instead of general State meetings, have science sections organized in the districts. The other seven States seem to have no similar organizations. In several of them however are science societies to which many of the high school science instructors belong. The Eastern Association of Physics Teachers is such an organization, the Ohio Physics Association is another. Most of these organizations are concerned with a single subject and not with all four high school science subjects, and are more interested in content matter than in methods of teaching, proper facilities for teaching, and the place of the sciences in the course of study.

Three of the 35 States with Science Sections in their State organizations have two separate groups, one an association of physics and chemistry teachers, the other of biology teachers. In a few States there are separate organizations affiliated with State Teachers Association composed of teachers of General Science. Whether such grouping is desirable or not depends upon the purpose of the organization. If it is primarily to discuss scientific subjects, the group organization is desirable. If it is to discuss the special problems facing the entire group of science subjects in the school curriculum, all science instructors in the high schools should meet in one organization. No definite understanding seems to exist concerning the program of the science section and what it had best undertake at its annual meeting.

The writer has visited several of the science meetings at State Teachers Association conventions and elsewhere in the past year or two and feels that it is time that definite steps be taken in practically every State to make them more worth while. A group of high school science instructors meeting once a year, listening to several papers on scientific subjects or on methods of teaching, however excellent they may be, has little effect of a permanent nature on the science teaching in the State. The science section should

have a definite stated purpose for its existence. It should function throughout the year. It must find work of a continuous character to keep its members working and interested. The work may be for individuals, committee groups, and district groups. All of the work should be in line with the stated purpose of the organization.

It does not seem to the writer that the science teacher ought to expect to obtain much science knowledge from the meetings of the science sections. He should get his scientific information from study and reading, and from attendance at the meetings of the scientific organizations, local, State and national, as far as possible. Local branches of the American Chemical Society, the Academies of Sciences, the American Association for the Advancement of Science, and others, hold frequent meetings in which high school teachers are active but are not represented by as large an attendance as there should be. Then there are a considerable number of other more or less national science societies whose meetings are places for the acquirement of science knowledge. The Department of Science Instruction of the National Education Association, the annual meeting of the American Association for the Advancement of Science, the two annual meetings of the American Chemical Society, the Central Association of Science and Mathematics Teachers, the Botanical Society of America, the New England Association of Chemistry Teachers, the National Association for Research in Science Teaching, the Geological Society of America, the Eastern Association of Physics Teachers, and others, all have programs filled with science information. High school instructors can not afford the expense of attending many of these national or sectional meetings but they should attend whenever they are held within reasonable traveling distance.

The activity of the science sections of the State Teachers Associations, in the opinion of the writer, should concern itself with questions related to the organization and improvement of the science teaching in the schools of the State through proper teaching methods and through State adopted standards for science departments, defining minimum qualifications and training of science teachers, maximum teaching loads, accessories for teaching such as

laboratories and equipment, the place of the science subjects in the curriculum and the number of hours to be devoted to each. An active science section, working in cooperation with the State department of education officials, will determine the standards which the State shall adopt. It will see that the sciences are given the recognition in the school curriculum that their importance in education and in everyday affairs warrants them to have. It can force the State office to use its full influence with local school units to see that they put their high school science departments on as good a basis as other departments by furnishing them with proper facilities for teaching and engaging as instructors only those with proper training and other qualifications.

The existence of an active science section in the State organization will have much direct influence with the local school authorities. It will have the same effect on them that the State Home Economics Associations have had. It will be able to help its member find ways and means of educating the local public to the value of the science courses. Its greatest work, however will probably be that done in cooperation with the State Department of Education in determining standards for science work in accredited high schools. Through cooperation with the State University and Colleges and institutions in the State preparing science teachers it can determine in large measure the courses to be offered by them to students who expect to be candidates for science teaching positions.

What is the best form of organization for the promotion of science teaching in any State can not be said. It depends upon the educational organization in the State for other matters. One State that has a successful association, has both a science section in the State Teachers Association and three division science sections, one in each of the three high school supervisory districts of the State. In States where more than one high school inspector or supervisor is employed in the State Department of Education and the State is divided by the Department into supervisory districts, these districts make convenient divisions for the organization of district branches of the science section of the State Teachers Association. There are probably about the

same number of schools in each and the teaching follows somewhat the same methods as the schools are under the same supervisor. The representative of the State is made an ex-officio member of the district science group, full co-operation resulting between him and the State Department and the science group.

In the State refered to, the State meeting is held in the early Fall each year. The science section meets at the same time and place. The three district groups meet twice a year in their own territory. They report their activities to the entire group at the State meeting. At this meeting the general program for the year is determined including the work of each of the three district groups. Certain studies have been undertaken for the State as a whole. The study in each of the three districts is made by the district group, the results put together by the officers or a committee of the whole. Some of the subjects of study in the past or now under way are: The training and experience of the science teachers of the State; the science teaching load and other duties of science teachers in the State; the valuation of the science apparatus and equipment in the high schools of the State; together with its suitability for present day science teaching; a general outline for a General Science course. Just what results will come from the studies are difficult to say. They will undoubtedly influence the State in setting up standards for science departments in schools which must be met before the schools will be accredited. Also the results put in the hands of local school authorities will cause them to make comparisons between their schools and those of nearby school units and those of the State as a whole, and will cause those in districts not up to the average to take steps to improve the science work in their schools.

Montana's District Science Teachers Association have undertaken valuable work. A review of that of the Eastern District was printed in this journal in April, 1931. It was prepared by Mr. F. B. Baldwin, chairman of the section. In it he discusses their convention program and their "all-year" program. This includes "commission studies," "individual studies" and their section bulletin published monthly to keep the members informed relative to the work

of the others and "with the results of the program as it progresses." During the present year a committee is studying the "Improvement of Classroom Procedure." Individual studies have covered a variety of subjects. The results have been published in the bulletin. The cost of printing the bulletin is defrayed from the annual dues of the members.

A committee of science men in Massachusetts has just completed a study of laboratory equipment. It has been published by the State Department of Education as a department bulletin. It is entitled "Equipment, Apparatus and Materials for Teaching Science in the Secondary Schools of Massachusetts." The report discusses the essentials needed for teaching the sciences including the space necessary for laboratories and supply rooms; laboratory furniture; needed apparatus and materials; care of apparatus; accessory equipment; and similar subjects. It contains lists of apparatus needed for the ordinary four high school sciences and the approximate cost of each item in the lists. It will undoubtedly become the standard on which Massachusetts high school science departments will be measured in the future. It will be a guide to school board members, superintendents and principals in determining what the science instructors are justified in requesting them to buy for their classes.

A valuable and worthy piece of work that might be undertaken by the Science Section and its local branches is the actual inspection and rating of the public school science departments in the State. It is not as big a job as it might at first seem. The inspections would be made by a number of small committees, none of them having many schools to visit. First they would have to meet and adopt uniform standards for rating the laboratories and equipment—a "score card" of some sort. The visits could be made in the evenings or on days when schools were not in session as there would be no attempt made to evaluate teaching. Before the committees visited the schools they would study over the inventory of each school science department, these inventories being made by the instructors in the schools. This in itself might seem to be a big piece of work. It is not. Most of the States now publish lists of apparatus and

equipment to meet the minimum requirements for science teaching. Copies of these lists can be furnished the individual instructors and they can check off on it against their own inventory the apparatus and supplies in their equipment. Whatever they have in addition to the items on the State list they may put on a supplementary list. Together with this list of apparatus each instructor should furnish a statement of his daily schedule, and a statement of his training for teaching and particularly for teaching sciences.

The returns from these reports and visits should be given to a central committee for tabulation. The results should be made available for school officials including principals. Laboratories for each subject should be rated as "excellent," "fair," "poor" "entirely inadequate" or similar terms. Science apparatus should be classified by the same designations. Teaching loads should be given by the number of periods per week for each teacher in science and in other subjects and for extra duties such as coaching athletics. Nothing could be published concerning the training of the individual teachers by which they could be identified, but summaries of their training in groups could be used.

The plan is not impractical as it might seem to those without experience in school survey work. It is similar to ones carried out in many school surveys made by the U. S. Bureau of Education and other organizations. The results when presented to school officials will bring action. Nothing seems to move them to action more rapidly than to show them through comparisons that the schools under their administration are not up to the standards of those of their neighboring communities.

RARE BIRDS WANTED

Where are the mounted museum specimens of extinct or near extinct species of birds?

Who has a passenger pigeon, a great auk, a heath hen? Burlingham Schurr, curator of the museum of zoology at Amherst College, wants to know.

He is broadcasting an appeal to all naturalists and museum curators to report briefly on the specimens they have of these birds or their eggs, as well as the Eskimo curlew, California vulture, Carolina paroquet, ivory-billed woodpecker and any other birds noteworthy for rarity, giving place and date of collection when these are known. It is Mr. Schurr's intention to publish a list, making the whereabouts of these rare specimens known for the benefit of all ornithologists. —*Science Service.*

AN OBJECTIVE TEST IN LOGARITHMS

By Laura Blank

Hughes High School, Cincinnati, Ohio

Surely the educator of today must be interested in all of the newer forms of testing, whether it is personality testing, intelligence testing or achievement testing, with all of their multiple forms, and their ideals of validity and reliability involving objectivity and extensive sampling, and the administrative features and statistical features. The teacher of mathematics wonders in how far it is desirable to carry over such types of testing into her own test making applied to her particular situations. Should one tend to build tests according to the new-type objective tests? Is this method applicable to many branches of mathematics? Does it test adequately our teaching objectives? Perhaps the most baffling question is that of trying to determine just what are our objectives in any particular branch of mathematics.

It seems more than likely that we shall never abandon entirely the older forms of written testing which because of their intensive sampling have so much merit in that they make provision for discovering depth of student information and ability to do. Yet for certain particular subject matter and abilities and aims within one branch of mathematics, the new-type objective test may lend itself most effectively to the teacher in her building of tests.

A test is herewith submitted which perhaps has merit, not so much as a means of grading the accomplishment of pupils—though it probably serves that end—as a means of taking an inventory of subject matter taught and perhaps mastered by the pupil. The test is constructed to endeavor to locate certain specific procedures and processes which may need group reteaching, or in which possibly individual and personal assistance and suggestion are necessary.

The test is divided into six sections, each, in the main, separate from every other. The items within a section are graded in difficulty, in so far as the technique of that section will permit. The total correct score planned for is 100. The test involves the true-false, completion, multiple-choice, matching, and correction-of-errors types of technique. The scoring can be made objective if part credit is

awarded in nó instance for a response in part incorrect, that is, if only right responses are given scores. The entire test as constructed can be scored with a stencil. In the true-false section the endeavor is made to diminish the element of chance and guessing by asking the pupil not to guess. However we may attempt to rule out the influence of guessing by applying the appropriate correction formula, $S=R-W$. Moreover there are twenty items in this section whereas the total correct score planned for this section was but 10. The element of probability is not nearly so high in the other sections of the test.

In the sections involving multiple choice and correction of errors, there are included among the possible choices most of the varieties of error made by pupils, so as to make the test truly diagnostic.

The six divisions of the test are ordered in the inductive or developmental plan of arrangement. The test is in that sense a unified summary, or organized résumé or survey of the subject.

TEST IN LOGARITHMS AND APPLICATION TO TRIGONOMETRIC FUNCTIONS

(FOR ELEVENTH OR TWELFTH GRADE)

Students are provided with tables of five-place logarithms of numbers and of trigonometric functions.

PART I. THEORY OF LOGARITHMS

Directions: Below are twenty true-false statements. Read each statement carefully. If you think it is true put T in the blank at the end of the line; if false, F.

Take each question in order. Skip the questions if you cannot decide. *Do not guess.*

(a) A logarithm is a coefficient . . . .
(b) Logarithms were invented by John Napier of Scotland . .....
(c) Logarithms to the base 10 are called Briggian logarithms . .....
(d) A logarithm is an exponent . . . .
(e) 5 cubed mutiplied by 5 squared equals 5, sixth power .....
(f) 3 cubed multiplied by 3, fourth power, equals 3 to the twelfth power . . . .
(g) 7, sixth power, divided by 7, cubed, equals 7 cubed . . ..
(h) 2 to eighth power, divided by 2, to the fourth power equals 2 squared . . . .
(i) 3 squared, then the entire quantity cubed equals 3 to the sixth power . . . .
(j) The cube root of (4 to the sixth power) is 4 squared . . ..
(k) The square root of the quantity 2 to the sixth power is 2 to the fourth power . . . .
(l) 10 with an exponent—2 means—20 . . . .
(m) The mantissa of a logarithm of a number is unchanged by any change in the position of the decimal point of the number . . . .
(n) 10 with an exponent—3 means .001 . . . .
(o) The number corresponding to a given logarithm is called an antilogarithm . . . .

(p) The mantissa of a logarithm is sometimes negative . . ..
(q) In our system of logarithms the log 10,000 is 3 . . . .
(r) In our system of logarithms the log 100,000 is 5 . . . .
(s) The log of $\frac{1}{10}$ is—1 . . . .
(t) The log .001 is—2 . . . .

PART II. APPLICATION OF THEORY TO CHARACTERISTICS

Directions: Below is a list of 20 numbers. Each number has a logarithm. The logarithm is composed of a characteristic and a mantissa. Write on the blank at the end of the line the characteristic *only* of the number at the beginning of that line.

(a) Characteristic of 1 is . . . .
(b) Characteristic of 52.468 is . . . .
(c) Characteristic of 524680 is . . . .
(d) Characteristic of 78910 is . . . .
(e) Characteristic of 23456 is . . . .
(f) Characteristic of 1.00079 is . . . .
(g) Characteristic of 23600 is . . . .
(h) Characteristic of 9.0023 is . . . .
(i) Characteristic of 524.68 is . . . .
(j) Characteristic of .00960 is . . . .
(k) Characteristic of .000006789 is . . . .
(l) Characteristic of 5246800 is . . . .
(m) Characteristic of .000056 is . . . .
(n) Characteristic of .19007 is . . . .
(o) Characteristic of 2.1360 is . . . .
(p) Characteristic of .000231 is. . . . .
(q) Characteristic of .965410 is . . . .
(r) Characteristic of 5246.8 is . . . .
(s) Characteristic of .56742 is . . . .
(t) Characteristic of .002347 is . . . .

PART III. APPLICATION OF THEORY TO MANTISSAS

Directions: Below are 10 numbers. Each number has a logarithm. The logarithm is composed of two parts, characteristic and mantissa. There are five possible mantissas at the right of each number, lettered respectively a, b, ... e. Only one of these mantissas can be true. Read carefully. Then decide which mantissa is correct. Write the letter preceding the correct one in the blank at the end of the line.

1. Is the mantissa of the log 2050 (a) 31197; (b) 16033; (c) 39794; (d) 31175; (e) 30211? . . . .
2. Is the mantissa of the log 30050 (a) 47784; (b) 48430; (c) 69897; (d) 19975; (e) 47720? . . . .
3. Is the mantissa of the log ½ (a) 30103; (b) 69897; (c) 07918; (d) 00860; (e) 10116? . . . .
4. Is the mantissa of log 1.024 (a) 00104; (b) 38021; (c) 00988; (d) 01030; (e) 13802? . . . .
5. Is the mantissa of the log .0004305 (a) 63397; (b) 63387; (c) 63849; (d) 10010; (e) 11041? . . . .
6. Is the mantissa of the log 20065 (a) 31492; (b) 81291; (c) 30246; (d) 15873; (e) 30244? . . . .
7. Is the mantissa of the log 53.435 (a) 34225; (b) 53593; (c) 72783; (d) 72864; (e) 10823? . . . .
8. Is the mantissa of the log 3.1416 (a) 15106; (b) 15076; (c) 20614; (d) 49715; (e) 20613? . . . .
9. Is the mantissa of the log ⅓ (a) 52244; (b) 52284; (c) 52288; (d) 47712; (e) 21543? . . . .
10. Is the mantissa of the log .024994 (a) 39777; (b) 39794; (c) 39784; (d) 10590; (e) 10591? . . . .

PART IV. ANTILOGARITHMS

Directions: The column at the left below gives 11 logarithms lettered, a, b, ... k. The next column is a list of antilogarithms. Look at

each logarithm on the left. Then find the antilogarithm in the next column which corresponds with the logarithm. Place the letter of the logarithm in the blank at the end of the line on which its antilogarithm is found. The first one is already done correctly as an example.

Logs.	Antilogs.	
(a) 2.00000	4.896	
(b) 0.90309	58769	
(c) 2.90309	377.42	
(d) 0.67669	0.04896	
(e) 0.68984	37.742	
(f) 3.68984	800.00	
(g) 4.76915	0.00567	
(h) 2.57682	0.000258	
(i) 8.68984—10	80.000	
(j) 7.75358—10	4896.00	
(k) 6.41162—10	5876.9	
	100.00	a
	47.50	
	8.000	
	4.75	

PART V. USE OF LOGARITHMS FOR MULTIPLICATION, DIVISION, INVOLUTION AND EVOLUTION

Directions: Fill in blanks at ends of lines. Use other paper for your work if necessary.

(a) Log 296 = ...
log 1.51 = ...
$\therefore$ log (296×1.51) = ...
$\therefore$ 296×1.51 = ...

(b) Log 29.6 = ...
log 151 = ...
log 49.993 = ...
$\therefore$ log (29.6×151×49.993) .....
$\therefore$ 29.6×151×49.993 = ...

(c) Log 15.1 = ...
log 2.96 = ...
$\therefore$ log (15.1÷2.96) = ...
$\therefore$ 15.1÷2.96 = ...

(d) Log 499.93 = ...
log square of 499.93 = ...
$\therefore$ square of 499.93 = ...

(e) Log 6400.3 = ...
log square root of 6400.3 = ...
$\therefore$ square root of 6400.3 = ...

PART VI. LOGARITHMS OF TRIGONOMETRIC FUNCTIONS

Directions: Draw a line through every incorrect logarithm in the following statements. If there is no error, write "Correct." Correct each error found by writing the correct logarithm in the blank at the right. The first three are marked correctly as examples.

(a) Log sin 37° 48′ 15″ is 9.78743—10	Correct
(b) log cos 49° 21′ is ~~.81388~~	9.81387—10
(c) log sin 67° 20′ is ~~9.58588—10~~	9.96509—10
(d) log tan 70° 41′ is 0.45529	
(e) log sin 37° 24′ 30″ is 9.78354—10	
(f) log cos 43° 30′ 30″ is 9.83788—10	
(g) log sin 65° 49′ 30″ is 9.96014—10	
(h) log cot 48° 10′ 4″ is 10.04812—10	
(i) log tan 68° 56′ 5″ is 0.41466	

HIGH SCHOOL BIOLOGY CONTENT AS JUDGED BY THIRTY COLLEGE BIOLOGISTS

By Otis W. Caldwell and Florence Weller

Institute of School Experimentation Teachers College, Columbia University.

There are several good methods of improving the subjects of study. None of these is free from important limitations. It seems desirable, therefore, to obtain the best results from each acceptable procedure, then, if possible, to combine what may have been learned from the use of the several dependable methods. Possibly, such combined results may minimize the limitations of single procedures, and may multiply evidences regarding the more important elements of the course of study. If this point of view is correct and is followed, it will prevent dogmatic conclusions from the use of any one procedure, or of any one person's particular way of working. Studies are needed regarding learning, regarding the social and individual uses of biology, as well as critiques of the content and method of existing courses in this subject.

Successful teachers of biological subjects in first and second college years would seem to be in a position scholastically, and by experience, to have gained some worthwhile ideas regarding what high school pupils do or should do in biology. This would seem particularly possible for those college teachers who previously taught in secondary schools, and who continue their interest in those schools. Furthermore, those of us who are engaged in curriculum work for secondary schools, instead of objecting to interference from college teachers, rather may find indispensable and sympathetic scholastic aid from college teachers who are in strategic positions to give such assistance. Aloofness on the part of curriculum workers from college subject specialists provides greater dangers to secondary science teaching, than does the chance of college dominance of secondary school subject matter. The biologists who teach in the early college years have been selected for their work by their superiors in the sciences and in college administration, and thus it would seem that these college teachers constitute a special group of unusual significance. Their scholastic and professional standing give importance to their opinions regarding biology insofar as they have had contact with it.

We secured twenty-one biology textbooks offered for use in

secondary schools.[1] Eleven of these, believed by us to be the most extensively used, were selected for detailed analysis as to their factual and topical content. An elaborate chart of these topics and their contents was developed so that the contents of each textbook could readily be compared with that of the ten others. A summary of all the topics on the chart was then prepared. This summary was condensed to four typed, single-spaced pages. Obviously, this reduction of all the topics and factual contents to a four-page summary caused the omission of some details which the biologist judges might wish to have seen before reacting to questions about the topics included. The alternative, however, would have been to include so many details that the judges would have found it difficult to have the time to complete the requested reports. Nevertheless, the omission of some details and consequent use of comprehensive topical outlines may be a source of an element of error in the final reports. It should be said, however, that but two of the thirty responses commented upon this omission.

A letter fully explanatory of the study was sent to each cooperating college biologist. In addition to securing opinions regarding inclusion and use of topics and factual material, it was asked that each biologist suggest added topics or procedures which he thinks desirable in secondary biology. Thirty-seven copies of the inquiry were sent out, and thirty responses received.

Information regarding the thirty responding college teachers will be of help. These thirty men are teaching in 29 different colleges and universities, as follows: Amherst, Barnard, Bates, Brooklyn, Brown, Cornell, Darmouth, Earlham, Reed, Rollins, Rutgers, Tufts, and Wabash; Universities of Chicago, Illinois, Iowa, Michigan, Nebraska, Ohio, Stanford, Syracuse, and Yale; State Teachers Colleges of Colorado (Greeley), Illinois (Charleston), New Jersey (Trenton), New York City, and Teachers

---

[1]The textbooks for analysis of course content are listed with the publication date of the copy used: Woodruff, L. L., "Foundations of Biology" (1931); Kline, N. S., "A Concise Biology for High Schools" (1925); Haupt, A. W., "Fundamentals of Biology" (1928); Hunter, W. H., "Problems in Biology" (1931); Kinsey, A. C., "An Introduction to Biology" (1926); Smallwood, W. M., Reveley, I. L., Bailey, G. A., "New Biology" (1924); Wheat, F. M., and Fitzpatrick, E. T., "Advanced Biology" (1929); Waggoner, H. D., "Modern Biology: Its Human Aspect" (1926); Peabody, J. E., and Hunt, A. E., "Biology and Human Welfare" (1924); Moore, T. J., "Biology for Beginners" (1926); Meier, W. H. D., and Meier, L., "Essentials of Biology" (1931). Texts reviewed but not used in the analysis presented in this study: Barrows, W. M., "Science of Animal Life" (1927); Trauseau, E. N., "General Botany" (1923); Chamberlain, C. J., "Elements of Plant Science" (1930); Pool, R. J., and Evans, A. T., "First Course in Botany" (1928); Smith, G. M., Overton, J. B., Gilbert, E. M., Denniston, R. H., Bryan, G. S., Allen, C. E., "A Textbook of General Botany" (1924); Hunter, G. W., "New Essentials of Biology" (1923); Wellhouse, W. H., Hendrickson, G. O., "A Brief Course in Biology" (1930); King, C. A., Martin, F. I., McCue, M. M., "Advanced Biology" (1928); Shumway, W., "Textbook of General Biology" (1931); Cunningham, J. T., "Modern Biology" (1929).

College of Columbia; State Agricultural and Mechanics Arts Colleges of Kansas and Iowa. Twenty-four of the thirty biologists took their doctorates in biological research; one took his doctorate in a department of education; and one's doctorate is honorary. We have no data regarding doctorates of the other four. Seventeen of the thirty did their own secondary school work in public high schools, 9 in academies, and 4 did not complete a regular secondary school course before going to college. Twenty-two of the 30 studied one or more courses in biology in secondary schools. Thirteen of the 30 later taught in secondary schools, the average years of such teaching being a little more than 5½. At least twenty-two of the 30 are recognized as contributors to biological knowledge. Twenty-seven report that they are now engaged both in teaching and in research. In response to the query which would be chosen if each one were required to devote all his time either to teaching alone or to research alone, 13 would choose teaching, 7 would choose research, 2 express doubt, 6 indicate that they would not accept a situation requiring such a choice, and 2 do not answer the question. Such a brief outline regarding personnel provides helpful but incomplete information about those who gave their judgments upon the topics of the inquiry.

The "Explanatory Note" which was used as a preface to the topical outline follows:

> The subject matter content of eleven textbooks designed for use in high school biology courses has been analyzed and classified. The number of these texts which include each topic is given in the first right-hand column. Will you please place a check mark (✓) in the second right-hand column of all topics you think should be included, leave it unmarked if you would omit it, and write a note or phrase in case you wish to qualify your reply. You may write this note or phrase in the spaces below each question indicating by letter the part of the question to which you refer. Also, add pages if you desire to express yourself more fully than possible on these sheets.

I. In the following paragraph there is presented the first question of the inquiry, its subdivisions, the percentage of the analyzed texts which include definitions of various subdivisions of biological science, the percentage of the college teachers who think that subdivisions and definitions should be included and the biological subdivisions which the teachers would add to the list given. When more than one biologist recommended additional subdivisions, the number recommending appears in brackets. In subsequent sections 14 other questions are treated in similar manner.

"1. Would you include definitions of the separate sub-branches of biology?	Percentage of Texts	Percentage of Biologists
a. Ecology	a. 45.5	a. 70.0
b. Taxonomy	b. 36.4	b. 66.7
c. Morphology	c. 27.3	c. 73.3
d. Genetics	d. 27.3	d. 66.7
e. Embryology	e. 9.1	e. 53.3
f. Anatomy	f. 9.1	f. 53.3
g. Physiology	g. 9.1	g. 73.3
h. Bacteriology	h. 9.1	h. 56.7

Add any others you would include."

Biological subdivisions teachers would include and define:

i. Histology	p. Sociology
j. Cytology	q. Paleontology (4)
k. Botany (4)	r. Plant Geography
l. Zoology (4)	s. Geology
m. Plant Pathology	t. Pathology
n. Animal Pathology	u. Eugenics
o. Psychology	v. Entomology

In every case the reporting teachers have suggested that the biological divisions that are included should be defined incidentally.

II. A problem which continues to be troublesome in teaching secondary biology relates to classification. It is clear from the textbooks and from responses from the college teachers that there is still wide difference of opinion on this point.

"2. Do you think it advisable to give exact and extensive classifications of plants and animals?	Percentage of Texts	Percentage of Biologists
a. Omit classifications as such	a. 27.3	a. 13.3
b. Simply name large divisions in index	b. 9.1	b. 13.3
c. Name large divisions with a short description of type for each	c. 27.3	c. 73.3
d. Give detailed structure and functions of at least one type in each group	d. 27.3	d. 23.3
e. Give large divisions in detail and name subdivisions but omit detailed structures	e. 9.1	e. 13.3

About what percent of the course to be devoted to this?"

The percentage of time recommended to be used in study of classification ranges from 0 to 40%. Significant statements by biologists are quoted.

> " "Taxonomic methods' comparisons, have fundamental value though not mainly as taxonomy." (R. C. Benedict)
> "30%, not over 40%, name phyla with some description, plus examples with some description." (F. C. Gates.)
> "Classification should be a very subordinate part of elementary work." (W. H. Sawyer)
> "Classification should be handled in some detail in an appendix and that much of the course can well be built about a broad taxonomic background. By so doing students discover evolution for themselves." (W. A. Allee)

"As little as possible; the learning of some common plants without regard to classification as a substitute." (L. H. Tiffany)
"If ecological and human relations are emphasized, I would devote perhaps one-third of the course to this subject, I think every student should know the place in the scheme of classifications of common plants and animals and how they live." (M. S. Markle)

III. Another question about which there has been considerable discussion is whether the biology course should include elementary instruction about the chemical constitution of matter.

"3. Would you devote any part of the course to the study of elements, compounds, matter, energy, physical and chemical change? In what part of the course and how much space to these topics?"	Percentage of Texts 45.5	Percentage of Biologists 83.3

Only 5 of 11 texts include this topic but the majority of the college teachers would include it. The space suggested for the topic is from 0% to 10% or 1 chapter. Eight teachers think that it should be given briefly in the early part of the course. Six think it should be introduced wherever needed. Others think it should be introduced in connection with structure of protoplasm, or nutrition of plants, or metalbolism, or photosynthesis, food, or physico-chemical basis of life processes, or to emphasize respiration, digestion, and excretion.

IV. Geographic distribution of plants and animals is notably scant in its treatment in biology textbooks. While there is wide variation between what the texts include and the percentage of the biologists who would give attention to this topic, some of the added comments indicate important limitations as well as advantages.

"4. Would you devote any part of the course to the geographic distribution of plants and animals? About what percent?"	Percentage of Texts 18.2	Percentage of Biologists 83.3

The consensus of opinion on this topic is that a brief general treatment should be included, from 1% to 10% of the whole course.

"Of but a few striking examples." (J. C. Uphof)
"No, the teacher will supply enough of this information." (W. H. Sawyer)
"As many field trips as may be convenient." (L. L. Burlingame)
"Yes, the concept of plant and animal formation; 10% of the course with plenty of illustrations of plants and animals." (L. J. Thomas)
"Not much more than examples of different plants in different parts of the country." (L. H. Tiffany)

V. There is recent tendency to include certain aspects of

human behavior as part of the course in biology. It is of interest that the texts analyzed and the responding biologists agree in including this topic but would not give it much space.

	Percentage of Texts	Percentage of Biologists
"5. Would you devote any part of the course to human behavior and mental hygiene? About what percent?"	72.7	80.0

While 8 out of the 11 texts include this topic and 23 of the 30 biologists checked it, the majority suggesting a brief treatment of from 2% to 12% of the course, there are a few outstandingly strong and important objections. Some of these are quoted below.

"No, we do not know much about mental hygiene. Poor teaching may result in serious consequences." (M. Meister)
"I doubt it; know little of approach to these phases of biology." (M. S. Markle)
"No, this is outside the scope of this course. Psychology and hygiene should take care of these." (P. R. Needham)
"Biology should not be a substitute for a course in hygiene." (M. A. Johnson)
"Treated as incidental to many structural and physiological conditions, not treated as definite subjects." (L. E. Griffin)
"Behavior, yes, behaviorism, no." (H. Neal)

VI. The legislative enactments of the different states, if enforced, would require almost universal inclusion of instruction regarding alcohol, tobacco and other narcotics. It is common knowledge that this requirement is often not taken seriously, or is wholly omitted. The scientific investigations dealing with the affects of these substances on humans, has not always been conclusive. The civic, social and educational difficulties involved in giving this instruction has often caused the efforts to be treated lightly. In a sense, it has become necessary for texts to include these materials lest they be cited as not conforming to legal requirements. It would be interesting to know how many authors of text books would include these topics if there were no legal requirements.

	Percentage of Texts	Percentage of Biologists
"6. Would you devote any part of the course to alcohol, tobacco, and drugs? About what percent?"	90.9	58.0

Although 10 out of 11 texts include this topic and 58% of the biologists checked it, suggesting that from 1/10% to 10% of the course be devoted to it, there is general disagreement among those who make remarks concerning it. The following quota-

tions include strong opinions for and against inclusion of the topics.

> "The moral and economic facts are fairly certain, the chemical and biological knowledge is very incomplete and uncertain." (L. E. Griffin)
>
> "No, outside the scope of this course." (P. R. Needham)
>
> "Doubtful; alcoholism might be mentioned in connection with heredity." (F. H. Fitzpatrick)
>
> "Not if I could avoid it." (L. L. Burlingame)
>
> "Yes; incidental to general nutrition and perhaps in hygiene." (R. C. Benedict)
>
> "Yes; too bad we have largely discontinued what we used to call 'scientific temperance'." "Give strong emphasis in connection with physiology and hygiene." (M. S. Markle)
>
> "Not a course in morality, but a true account of the known effects of these on the human body or that of animals." (L. H. Tiffany)

VII. The substitution of a human physiology and hygiene course for the common biology course is not approved by the biologists. However, 5 of the 11 text books analyzed do advocate inclusion of discussion of human structures and functions in the biology courses.

	Percentage of Texts	Percentage of Biologists
"7. Should the primary emphasis be given to human organic structures and functions or to the structures and functions of other animals and plants?		
a. General structures of typical plants and animals not including man	a. 18.2	a. 6.7
b. Structures and functions of plants and animals including man	b. 36.4	b. 93.3
c. Structure and functions of man only	c. 45.5	c. 0

The reporting biologists agree almost completely on topic *b*. L. J. Thomas suggests that 50% of the course be centered around this. No other suggestions are made on this topic.

VIII. In distinction from a biology course definitely organized about human structures and functions, there is the question of giving separate topical treatment of human hygiene. The opinions are definite and most suggestive.

	Percentage of Texts	Percentage of Biologists
"8. Would you devote part of the course to hygiene?		
a. Include care of the special organs	a. 72.7	a. 56.7
b. Include public health (community and nation)	b. 72.7	b. 83.3
c. Include study of foods"	c. 81.9	c. 76.7

General agreement appears between the texts and the biologists to the effect that this is an important topic. L. L. Woodruff suggests that this together with topic No. 7 compose 75% of the entire biology course.

IX. Ecology of plants and animals was stated in a way that was designed to secure responses not only to the general topic but to some of the special sub-topics of ecology. A study of the responses is more convincing than appears at first glance, but there is great variation in judgments.

		Percentage of Texts	Percentage of Biologists
"9. What percent of the course would you devote to the ecology of plants and animals?			
a.	Economic value of plants and animals	a. 45.5	a. 90.0
b.	Weed control	b. 9.1	b. 46.7
c.	Insect pest control	c. 54.5	c. 76.7
d.	Household pests	d. 9.1	d. 56.7
e.	Ecology of one organism	e. 9.1	e. 30.0
f.	Conservation of wild life (flowers—trees—birds—fish—mammals)	f. 63.6	f. 86.7
In what form would you give it?"			

Texts and biologists agree fairly well on *a*, *c*, and *f*, the reporting biologists more strongly favoring these points than do the texts. However, there are many comments on this topic and little agreement among them. It is suggested that from 30% to 55% of the course be devoted to it. Important comments are quoted.

"Field trips if possible, museum trip, aquarium studies, some reading." (W. A. Allee)

"Too extensive for a high school except where superficially taught." (J. C. Uphof)

"Ecology of man. This should be followed by man's relation to other men, i. e., sociology (cooperation, competition, struggle for existence, need of wider cooperation)." (W. H. Wellhouse)

"Ecological relations intrinsic to many general topics needed in many economic types as illustrative of general principles." (R. C. Benedict)

"Natural history, omit any division as an 'ology' but rather spend time on the place in nature, the value both economic and aesthetic in developing a true conservation point of view." (P. R. Needham)

"Twenty-five percent of course in separate unit on ecology and its economic importance." (F. H. Fitzpatrick)

"None; direct ecology is simply the environment of the organism—it should always be included—never treated separately." (L. E. Griffin)

"Not usually in separate chapters. Use as problems to introduce study of groups, etc." (W. L. Eikenberry)

"I wouldn't put the ecology in separate compartments. Idea of inter-relationships should prevail throughout course." (M. S. Markle)

"Fungus parasites should be added." (E. W. Sinnott)

X. The processes of metabolism and structure of protoplasm which many biologists would regard as essential to any worthy biology course, do not receive the full approval of all the teachers as was expected.

	Percentage of Texts	Percentage of Biologists
"10. The structure of protoplasm and the processes of metabolism.		
a. Definition and qualities	a. 72.7	a. 90.0
b. Constructive metabolism	b. 63.6	b. 90.0
c. Destructive metabolism	c. 9.1	c. 86.7
How much would you include?"		

From 2% to 30% of the course is suggested for this topic. There is general agreement that the topic should be included but great difference in judgment as to amount of time needed for it.

"Including physiology in general about 30% of the course. An understanding of photosynthesis is especially important." (E. W. Sinnott)

"Enough for an understanding of the important syntheses and respiration." (E. L. Stover)

"Whatever is necessary for an elementary understanding of how a plant lives and works; how an animal lives and works; and the whole energy concept with reference to living things." (F. C. Jean)

"This is the basis of biology and should be thoroughly dealt with at the beginning of the course." (W. H. Sawyer)

"Brief statement; weave this into the general structure of the course. All aspects of metabolism—photosynthesis in plants to respiration and excretion in man; some chemical processes included." (H. Neal)

"Drawings of cells and laboratory exercises on cells. (1) Photosynthesis. (2) Fat and protein synthesis. (3) Digestion. (4) Respiration, 2, 3, 4 in both plants and animals." (M. A. Johnson)

"Under nutrition and other instances of cell activity use repeatedly as basis of all actions." (R. C. Benedict)

"Fairly complete survey with a single plant and animal type." (H. H. Plough)

"Omit most definitions. The morphology of parts should go side by side with functions of parts and this topic should be taught thoroughly and concisely." (P. R. Needham)

XI. In spite of, possibly because of, the agitation about evolution the sub-topics under this heading receive extensive approval both in the texts and responses of biologists. The texts are low on relation between heredity and environment, and on animal breeding and eugenics; but the biologists give high rank to all the sub-topics.

Most texts and the biologists would include this topic. In the written statements from a few pages to 20% of the course is suggested. Only one dissenting statement is made, but the comments suggest limitations.

	Percentage of Texts	Percentage of Biologists
"11. Heredity and environment.		
a. Mendelian law	a. 90.9	a. 93.3
b. Practical applications of Mendel's law	b.	b.
(1) In plant breeding	(1) 90.9	(1) 93.3
(2) In animal breeding	(2) 36.4	(2) 86.7
(3) Eugenically	(3) 54.5	(3) 73.3
c. Evidences for evolution	c. 100.0	c. 83.3
d. Relationship between heredity and environment	d. 18.2	d. 90.0

How much would you include?"

"Two hours eugenics; never in high school except correct definitions; smattering of knowledge breeds anti-situations." (A. R. Becktel)

"Difficult for high school students, should be well illustrated." (H. Neal)

"Fairly full statement; I would emphasize the evidence for evolution and say little of the theories concerning it." (W. A. Allee)

"Definitions, examples, and suggestions." (F. C. Gates)

"Every organism has both heredity and environment. As simple, direct, and brief a statement as possible." (L. E. Griffin)

"Enough to give a basis for safe thinking." (L. H. Tiffany)

"Mendelian laws, evidences of evolution as shown by Darwin, Wallace, and others, and their practical significance in plant and animal breeding." (P. R. Needham)

XII.

	Percentage of Texts	Percentage of Biologists
"12. Would you include any theories of the origin of life?		
a. Mechanistic and vitalistic theories	a. 9.1	a. 30.0
b. Biogenesis	b. 9.1	b. 6.7
c. Cosmozoa	c. 9.1	c. 6.7
d. Pfuger's theory	d. 9.1	d. 0.0
e. Moore's law	e. 9.1	e. 0.0
f. Allen's theory	f. 9.1	f. 0.0
g. Troland's theory	g. 9.1	g. 0.0
h. Osborn's theory	h. 9.1	h. 0.0
i. Huxley's statement	i. 9.1	i. 10.0

Added comments."

It is generally agreed to omit this topic. Quotations follow:

"I would omit the theories as named above and stick to facts. There is enough to know aside from filling minds with the 'confusions' of biologists." (P. R. Needham)

"In general doubt detailed division indicated. Would be satisfied with a reference where the pupils interested could look this topic up if they wished." (F. C. Gates)

"Needs careful treatment. We do not know enough. Include just enough to whet the imagination and not enough to be dogmatic." (W. A. Allee)

"Only the fact that there are several theories and a brief discussion of one or two important ones." (M. Meister)

"Too speculative. Darwin wisely refrained from guessing. Any statements concerning the origin of life are only unfounded guesses." (H. Neal)

"Only if students asked about it and then not in detail." (A. E. Emerson)

"Theories that have not definite proof only confuse the beginner. Present the facts and methods of arriving at conclusions and leave the beginner to largely work out his own theories. The high school student is not mature enough. Too much information and detail should be avoided." (L. J. Thomas)

XIII. The past two decades have seen a strong tendency to include biographies of biologists in high school instruction. The list in the inquiry included 30 names which are given in two or more of the text books. Some of the 16 names added by one or more of the biologists appear in one of the text books. Altogether, there are 46 names of biologists, and others could easily be added.

"13. Check once the men you would mention and whose work would receive explanation. Check twice those that you would include in more detail.		Percentage of Texts		Percentage of Biologists		
				Check once	Check twice	Combined
a. Pasteur	a.	90.9	a.	36.7	60.0	96.7
b. Mendel	b.		b.	56.7	43.3	100.0
c. Charles Darwin	c.	72.7	c.	36.7	56.7	93.4
d. Huxley	d.	63.6	d.	56.7	3.3	60.0
e. Lamarck	e.	54.5	e.	56.7	6.7	63.4
f. Leeuwenhoek	f.		f.	66.7	13.3	80.0
g. Hooke	g.		g.	46.7		46.7
h. Burbank	h.		h.	40.0		40.0
i. Linnaeus	i.		i.	60.0	16.7	76.7
j. Koch	j.	45.5	j.	63.3	6.7	70.0
k. Lister	k.		k.	60.0	3.3	63.3
l. Schleiden	l.		l.	53.3	6.7	60.0
m. Schwann	m.		m.	56.7	6.7	63.4
n. Weismann	n.		n.	30.0	3.3	33.3
p. Harvey	p.	36.4	p.	50.0	6.7	56.7
q. deVries	q.		q.	46.7	3.3	50.0
r. Ehrlich	r.		r.	13.3		13.3
s. Audubon	s.		s.	40.0	6.7	46.7
t. Agassiz	t.		t.	43.3	3.3	46.6
u. Aristotle	u.	27.3	u.	53.3	3.3	56.6
v. Redi	v.		v.	30.0		30.0
w. Priestly	w.		w.	13.3		13.3
x. Jenner	x.		x.	36.7	3.3	40.0
y. von Mohl	y.		y.	16.7		16.7
z. Hippocrates	z.		z.	10.0		10.0
aa. von Baer	aa.	18.2	aa.	20.0		20.0
bb. Fabre	bb.		bb.	16.7	3.3	20.0
cc. Tyndall	cc.		cc.	6.7		6.7
dd. Schultze	dd.		dd.	13.3		13.3
ee. Dujardin	ee.		ee.	6.7		6.7

Add names of others you would include."

The following additions have been made:

1. L. O. Howard	6. J. Burroughs	11. Lavoisier
2. C. W. Stiles	7. D. S. Jordan (2)	12. Ingen Housz
3. Goldberger	8. von Humboldt	13. Reed
4. F. Galton	9. Malthus	14. Spallanzani
5. Asa Gray	10. R. Brown	15. Lyonet
		16. Swannerdam

By combining the scores of those who checked a name once with those checking it twice, and selecting all names with a combined rank of 50 or more, a list of 13 names is secured as a reasonably small biographic list. Such a list includes Mendel, Pasteur, Charles Darwin, Leeuwenhoek, Linnaeus, Koch, Lamarck, Schwann, Lister, Huxley, Schleiden, Harvey, and deVries.

"Here is an idea, develop facts around workers." (A. R. Becktel)

"One of the best devices for putting over various phases of biology is through the human exponents." (H. E. Walter)

"Why not a few well known living men? Surely we do not have to wait 50 or more years after they are dead." (A. E. Woodhead)

XIV. A group of questions regarding helps in teaching biology were included.

	Percentage of Texts	Percentage of Biologists
"14. Would you include any of the following devices as helps to study?		
a. Questions	a. 45.5	a. 70.0
b. Summaries	b. 27.3	b. 60.0
c. Laboratory experiments to be done	c. 36.4	c. 63.3
d. Laboratory experiments with results	d. 9.1	d. 23.3
e. Glossary at end	e. 45.5	e. 76.7
f. Vocabulary within the chapter	f. 27.3	f. 20.0
g. Tests	g. 9.1	g. 36.7
Would you recommend a laboratory manual or a work book separate from the text?		yes 60.0 no 6.7

The biologists are generally in favor of questions, laboratory experiments and a manual, also some favor a glossary.

A significant comment on this topic is:

"So many teachers of biology are not trained in the subject that a real manual is very desirable." (A. E. Woodhead)

Summary

1. A detailed analysis was prepared of the course content in biology as presented in 11 text books. A four-page summary of this analysis was presented to college teachers of biology with the request for their judgment of the course content. Thirty of the 37 biologists to whom the inquiry was sent gave their responses to the many questions that were asked.

2. Between two-thirds and three-fourths of the college biologists reporting would increase subdivisions of biology, and would present brief definitions of each one.

3. Classification of plants and animals according to nearly all the judges would be given slightly less attention, although relatively small space is now given this topic in most of the text outlines. However, most recommend naming the large divisions and giving a short description of one type form for each large division.

4. Over one-fifth of the judges think the course should include brief study of elements, compounds, energy, physical and chemical change.

5. Geographic distribution of plants and animals, a topic which is not now well represented in the course, is recommended by more than four-fifths of the judges.

6. Human behavior and mental hygiene would receive relatively small consideration by the judges, though most of them would include the topic.

7. Although more than 90% of the texts treat alcohol, tobacco, and drugs, less than two-thirds of the biologists would include these topics and those would not give extensive treatment to them.

8. Almost none of the judges would have a biology course either omitting man or making man the leading feature of the course. All but two would compose the course of structures and functions of plants and animals including man.

9. Almost all would include care of special human structures, public health, and study of foods.

10. In ecology, the aspects recommended by nearly all the biologists are, economic value of plants and animals, insect pest control, and conservation of wild life.

11. Processes of metabolism would be included by almost all the judges.

12. Almost all would include heredity and environment, but would not give large space to the topic.

13. Theories of evolution would be given scant attention.

14. Biography of a dozen or more biologists would be included, the list consisting of men who have made the most fundamental contributions to biology.

15. Recommendations regarding teaching helps are many and divergent.

Such an inquiry as this cannot be expected to provide final

evidence regarding the content of the high school biology course. The professional standing of the 30 reporting biologists, which is based upon their scientific training, their contributions to biological knowledge, their teaching experience, and their interest in science education, constitutes one important source of judgment of high school biology. Other inquiries regarding the content of biology have been made, and still others are needed. The final criteria of determination will probably result from measured experimental use in high schools. We must not overlook the fact, however, that the courses now being taught have been tested and are being tested by trial, even though exact measurement of results has not yet been adequately applied. The judgments provided by these 30 biologists would support the greater part of the course content as outlined, would omit some parts, add to other parts, and introduce some new elements. These responses would seem, therefore, to give some increased clarity as to what to teach in secondary biology.

A STUDY OF THE TREND IN SCIENCE

By SUSIE M. VICK,
Washington High School, Raleigh, No. Carolina.

Of the sixteen units required for graduation from this high school, two must be in Science. The students after receiving these two units, usually General Science and Biology, seemingly do not care to take further work in science, but choose courses in languages and history instead. The question arose, Why do students shun Sciences? A study of the situation was made through the questionnaire method and the results are given here.

In the Washington High School, three sciences are now given, General Science, Biology and Chemistry. There is an equipped Physics department but the subject has not been taught since 1929-30, one reason being because the number of pupils who wanted the course was too small. The Biology class is usually large because it completes the two-year requirement. The chemistry class is usually small because it is an elective subject. This year there are five girls and one boy in it. They are taking the course to complete their two-year requirement. The questionnaire was given to 118 boys and 204 girls. The writer

has come to the conclusion from the answers that two things are necessary:

(1) In order to overcome the belief that "science is hard" the courses must be made very interesting, but not to the extent that important scientific facts and principles be overlooked.

(2) The elective courses have to be presented in such a manner that they will not suffer from lack of students. She is also convinced that the sciences should be compulsory for at least three years for the pupils who are going to college, and to widen the scientific outlook and appreciation of those who end their studies with the high school.

The questions and answers are as follows:

1. Did you elect science when you first entered high school?
   Yes—55 boys, 100 girls.
2. Did you like or dislike science after one year?
   Like—70 boys, 129 girls.
   Dislike—15 boys, 27 girls.
3. What sciences have you taken?

General Science	89 boys,	157 girls.
Biology	34 boys,	67 girls.
Chemistry	13 boys,	9 girls.
Physics	1 boy,	2 girls.

4. What science do you like best?

General Science	54 boys,	80 girls.
Biology	17 boys,	38 girls.
Chemistry	16 boys,	14 girls.

5. Would science be more interesting without mathematics?
   Yes— 14 boys, 34 girls.
   No—100 boys, 18 girls.
6. Do you shun science courses because they take more time?
   Yes— 4 boys, 6 girls.
   No—100 boys, 163 girls.
7. Would you prefer teacher demonstration work only?
   Yes—13 boys, 54 girls.
   No—93 boys, 121 girls.
8. What subjects do you consider hardest in the high school course?

Latin	60 boys,	76 girls.
History	11 boys,	50 girls.
French	25 boys,	25 girls.
Mathematics	50 boys,	50 girls.
Science	12 boys,	12 girls.
English	18 boys,	14 girls.

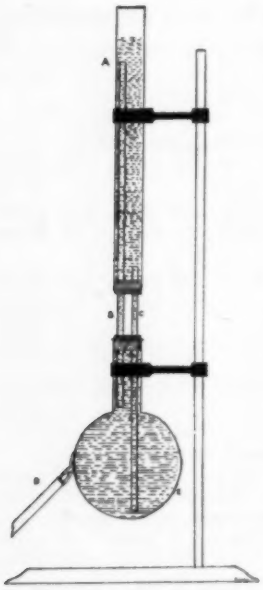
9. What do students say to make one dislike and not elect sciences?
   "It is hard," "Note-book is hard," "Too much mathematics," "Takes too much time," "It is dirty," "Theory too hard."
10. Why do students prefer history and languages?
    "Easier," "Less work," "Less time needed," "No note-book," "Like subject better," "More interesting."
11. What would make the sciences more interesting?
    "More project work," "More field trips," "More laboratory work."

DEMONSTRATION OF CONVECTION CURRENTS

By Robert H. Long

State Teachers College, Shippensburg, Pa.

In view of the fact that it is rather difficult to demonstrate the principle of convectional currents to high school pupils in a very concrete way, the following experiment was devised to make the idea clearer. The materials are such as may be found in any high school laboratory, and the apparatus can be quickly and easily set up and put in operation.



The apparatus, as shown in the illustration, consists of a section of glass tubing about sixteen inches in length and one inch in diameter (A), two smaller sized pieces of tubing (B and C), one glass flask (E) of about 500 cubic centimeter capacity, two ring-stand clamps, a source of heating flame, two rubber stoppers containing holes for the smaller sections of glass tubing and of such sizes as to fit the tube A and the flask respectively. Other materials needed include water, 25 cubic centimeters (approximately) of concentrated sodium hydroxide or potassium hydroxide, and a small amount of phenolphthalein.

The apparatus is then set up as shown in the illustration, the flask being filled with a diluted solution of the hydroxide before the stopper is placed in it. Then the entire system is filled with the hydroxide solution to a point about two and one half inches from the top of tube A, this space being left to take care of the expansion of the solution due to the heating of it.

The apparatus is then ready for the demonstration. The flask is heated at a point farthest away from tube C and near the point of greatest circumference. When the solution has become well heated (this being noted by the expansion of the liquid at the top of the open tube), the

phenolphthalein is added at the top of tube A. The solution near the top of the tube will turn to the usual pink color due to the reaction of the phenolphthalein and the hydroxide. Then, the heat still being applied, the path of the convectional currents can be traced as the colored solution diffuses down through tube C into the flask. The newly formed colored solution is also heated, thus expanding, and it rises through tube B. A complete and clearly visible circulation of a liquid, due to heating, is thus to be seen.

GEOGRAPHY IN THE UNIVERSITY

"Geography as a study was once confined to elementary schools, but now its teaching has grown in importance until nearly every university has a separate department for it," said Major Sidman P. Poole, professor of geography at Syracuse University in a recent interview. Professor Poole was geographer of the Syracuse University Andean Expedition which last year explored a little known part of interior Venezuela.

"When we recognize that geography is the stage on which the drama of history is played we see that close acquaintance with it as a science is necessary in order to understand fully the political news of the day."

"Look at the Manchurian situation from the viewpoint of geography," said Major Poole. Japan is seeking territory in which to grow food for its millions and raw materials for them to manufacture and export.

"Through geography," he said, "we see that Japan can cultivate only 15 per cent of its land. To lessen its dependence on the outside world it must possess Manchuria.

"On the other hand, China needs the wheat and beans of its northernmost province. But Manchuria is almost no good to China. There is but one means of transportation from the north, the small railroad from Mukden that runs southward to Pekin. This at present is not operated to any extent.

"Until adequate railway lines are constructed into Manchuria, this province will remain theoretically nearer Japan than China. Japan, with an increasing population and increasing importance as an industrial nation, must reach out, and the logical place to do this, from the standpoint of geography, is Manchuria. So the trouble there is fundamentally not political, but geographic.

"A vulnerable point in the sovereignty of Italy is its lack of natural resources," Major Poole indicated. "In peace time it manages to get them from abroad. In a time of war Italy would be hugely handicapped since it has within its borders little coal, petroleum, iron or copper. It also cannot sustain itself, particularly in a time of war, in the matter of food."

France, on the other hand, with a diversity of agricultural products and supplies of iron and other raw materials, including coal, and with a diversity of industries, none greatly overdeveloped, is an extremely favorable condition, he thinks.

SCIENCE QUESTIONS

April, 1932.

Conducted by Franklin T. Jones.

To Readers of School Science and Mathematics:

You are invited to propose questions for solution or discussion. Send in answers to questions.

Examination papers are always desired, send in your own papers or any others. Tests and new things are wanted.

Please address all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E., Cleveland, Ohio.

WHO IS THE ENGINEER?

595. *Answers have been received from*—J. S. Georges, Chicago; H. S. Lein, North Tonawanda, N. Y.; A. P. Kenyon, Chadwick, Ill. Rose S. Vormelker, Cleveland Public Library; The Scarab, East Technical High School, Cleveland.

TESTS IN BIOLOGY

598. *Submitted by A. H. Bryan, Baltimore City College, Baltimore, Maryland.*

I am enclosing the complete set of achievement tests, true and false tests, and general review examinations used in my biology classes in the above high school throughout the year. These tests have been used with some moderate changes within the last few years, because they cover all topics in biology, systematically both in theory and laboratory work, you might be interested in publishing some of them. There are so many, of course, that I would suggest you just print one at a time when you have available space for examination questions.

Set No. 1 are not original but designed as a general review set of questions covering every topic in biology. They were culled from several well known text books and quiz compends. The students were given one set of these question papers just before the end of the term. They were required to write out and study the answers to all of the hundred questions. For the actual examination ten questions were picked out of the hundred by the biology teachers here and then given as the final examination for all classes. This complete review proved particularly valuable to students who had to take college entrance examinations.

Achievement test No. 2 covers a series of questions to be given at the end of the first two months work in biology, covering the field of botany dealing with the spermatophytes. If insect is correlated in the course of study with botany in order to show interrelationship with plant and animal life, questions 56 to 72 cover questions on insect study.

Chart test No. 3. This is an achievement test in laboratory work covered in the botanical phase of biology. Every diagram has a number of figures pointed at certain parts. The student is required to name the part pointed to corresponding to the number or letter. This is a practical examination designed to test achievements in the laboratory work in the subject.

Test No. 4. The chapters in the text on bacteriology and hygiene are of such importance that at the conclusion of the work an achievement test is given. It consists of 70 questions, all of which are answered on a separate paper with the mimeographed sheet returned to the teacher at the close of the period. Because cheating is very easy in this type of examination the teacher should resort to ambulatory method, walking around the class room at intervals. The students are required to keep their answers covered by a book as fast as written. They are cautioned that if the teacher

is able to see the answer to more than one question on the paper, they will be disqualified from the examination. If marking the paper is an acute problem, the teacher can use this type of review examination as a review the next day and pass out a set of papers from another group. The questions are gone over as a quiz and if the answers are incorrect the students draw a line thru the question, greatly helping the teacher to grade the papers.

Test No. 5. Test in Zoology in which six diagrams of animals to be studied in the zoology phase of the work in biology are used as a quiz. Students are required to name the parts which are shown and also questions on these parts.

Examination No. 6. The work in biology is completed with almost six weeks study of human physiology. This achievement type of test covers the subject accurately. The same regulation covering the conduct of the test and the same method of marking can be used as in the others of similar type.

Test No. 7 is a true and false test of twenty-five questions based on the botanical phase of biology.

Test No. 8 is a series of 199 questions taken from various texts in the zoological and human physiological topics. Appended to them are the questions and the answers for convenience in marking. This set of 199 questions can be used as a complete review of the second term's work in biology just in the same way that examination set No. 1 covers the whole subject.

I hope these will be of some service to you. I have noticed in perusing your magazine, copies of which are in our school library, that you have a section devoted to examinations so I thought you might be interested in examination experience that I have gleaned through several years of teaching in the above school. This set of examinations, I believe, cover as a whole, everything there is on the subject.

Yours truly,

A. H. BRYAN.

Achievement Test 2—Biology—Bryan

Set No. 2 on Spermatophytes is printed below. Readers who wish to have the other tests printed please send in their requests to the Editor.

SET NO. 2—SPERMATOPHYTES

1—Study of living things, plants and animals, called what?
2—Study of functions of living things called what?
3—Another name for our surroundings.
4—Name four elements present in plants or animals.
5—Name
6—Name
7—Name
8—Name three factors of environment.
9—Name
10—Name
11—Word meaning transfer of pollen.
12—Word meaning union of sex cells in plants.
13—Two methods of pollination.
14—Two
15—Material in cell which is unit of life.
16—Center of function of cell called what?
17—Two methods of cell reproduction.
18—Two
19—Four things protoplasm can do.
20—Four
21—Four

22—Four
23—Baby plant inside seed called what?
24—Name one plant whose seeds are dispersed by wind.
25—Grease spot on paper is test for what?
26—What substance used as test for starch?
27—What color does H N O_3 turn protein?
28—What enzyme changes starch to sugar?
29—Two functions of root.
30—Two
31—Word meaning diffusion of liquids through plant membrane.
32—Two reasons why roots grow downward.
33—Two
34—Rich organic soil called what?
35—Through what does soil water pass to get into roots?
36—Name one plant useful in crop rotation.
37—Process giving off water from leaf?
38—Leaves turn toward what?
39—What makes a leaf green?
40—Process food manufacture in leaf called what?
41—What element, a gas, does a leaf give off?
42—What compound does a leaf take in?
43—Microscopic pores in leaf called what?
44—What is source of energy for food manufacture?
45—Name two raw products in Photosynthesis.
46—Name
47—Name one waste product in Photosynthesis.
48—Name two products resulting from above process.
49—Name
50—What guards entrance to stomata?
51—Name two kinds of roots.
52—Name
53—What protects Meristem?
54—Term for growing point.
55—What forms on roots of leguminous?
56—Name three parts of the body of an insect.
57—Name
58—Name
59—Give one example of the class Crustacea.
60—Give one example of the class Arachnida.
61—Give one example of the class Centipedes.
62—Give one example of the class Insecta.
63—Give one example of the class od. Hymenoptera.
64—Give one example of the class Arthopter.
65—Give one example of the class Deptera.
66—Give one example of the class Lepidoptera.
67—Give one example of the class Coleoptera.
68—Give four stages of complete metamorphosis of insects.
69—Give
70—Give
71—Give
72—What is dormant stage of insect metamorphosis called?

A THOUGHT PROVOKER

599. "If fluids may be colored red, green, blue, etc., and yet remain crystal clear, why can we not do the same with white and black?"

Proposed by F. H. Wade, Lewis Institute, Chicago.

A THOUSAND YEARS HENCE

600. *Proposed by J. C. Packard, Brookline, Mass.*

To stimulate the imagination, ask yourself this question and try to answer it.

What scientific achievement would be worth the sustained effort of the human race for a thousand years and the expenditure of uncounted millions of dollars to accomplish?

601. Was the first horseless carriage a chariot?

---

602. HOW DOES THE OTHER HALF LIVE?

*Did You Know?**

1. That man is parasitized by 25 species of protozoa, 85 different species of worms and an unknown number of different species of arthropods.
2. That there are at least as many species of animal parasites as there are species of animal hosts for them to live in.
3. That when one observes a colleague he may think he is seeing an individual, whereas, as a matter of fact, he is really looking at a menagerie.
4. That the protozoan parasites of man live, one group in the digestive tract (intestinal protozoa) and the other group in the blood stream (blood-inhabiting protozoa).
5. That about one-half of the general population are infected with a mouth-inhabiting amoeba.
6. That there are ten (or more) different species of protozoa in the large intestine.
7. That 10 per cent of the general population is infected with the dysentery amoeba.
8. That vegetarian animals are very highly parasitized.
9. That eating cheese is effective in preventing infections, and that eating starch or sugar intensifies infections.

603. What is the fastest mile ever traveled on land?

WANTED

More Thought Provokers.—The Editor.

A SIMPLE DEVICE FOR DEMONSTRATING THE ACTION OF THE PHOTO-ELECTRIC CELL

BY HERBERT S. LEIN

Bennett High School, Buffalo, N. Y.

Most of us who earn our livelihood through the teaching of science are often confronted with the questions of students who doubt the value of pure science to, let us say, material prosperity. It is no easy matter to satisfy the curiosity of pupils by mere talking and required reading.

How can the discovery, for instance, that light striking the surface of the alkali metals under suitable conditions brings about the ejection of electrons ever pay any dividends. No industries, whose shares will be quoted on the stock exchange are likely to be founded upon it.

Big as is the contribution of physical discovery to material prosperity, there are large areas of its domain far

*"*How The Other Half Live*" by Professor Robert Hegner. SCIENCE, Feb. 26, 1932, pp. 225-230.

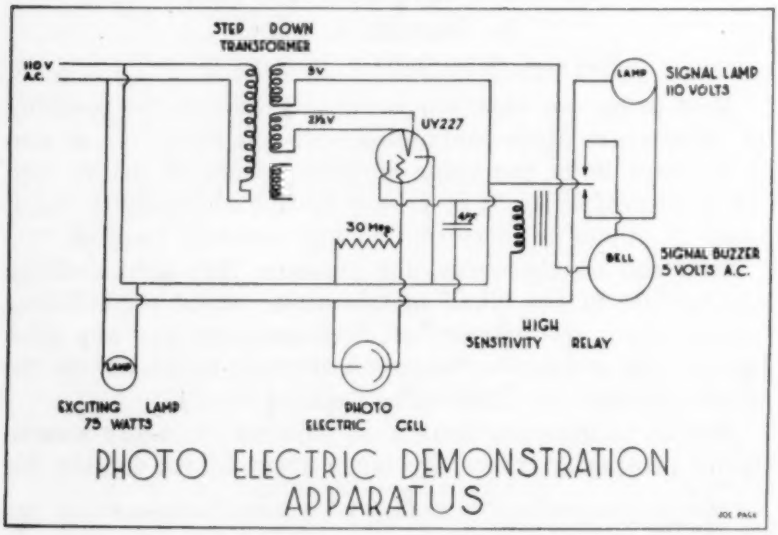
removed from such considerations. Whether light consists of waves or particles is of more than academic moment. The phenomena of physics are universal in their appeal and it is to the glory of physical discovery that the practical products of its research are incidental, and never the main objective.

The accompanying diagram shows how a photo cell, amplifying tube type 227, a relay in the plate circuit of the tube, a buzzer and a 110 volt A. C. power supply may be used to make a simple demonstration of the utility of a pure science discovery.

By cutting off a beam of light directed toward the cell the number of electrons emitted by the clean metal surface in the photo electric cell is changed. In series with the cell is a large resistance across which is developed an I R drop where the I is the small current dependant upon the electron emission. When this electron emission is reduced by cutting off the beam of light a drop in the potential difference across the resistance results.

This resistance is connected between the grid and cathode of the amplifying tube. Hence variations in the plate current of this tube are available for the operation of a relay when changes in the I R drop across the resistor occur.

The relay may be used to control a buzzer, turn lamps off or on, or perform other operations.



The fact that the set up shown in the accompanying diagram operates direct from a 110 volt A. C. power source without the use of additional batteries is a matter of great convenience.

This demonstration can very easily be made the starting point of a general discussion of elementary electron theory and later some of the commercial applications of the photo electric cell as in television, the counting of automobiles, the shutting on and off of street lights in the cities, and countless other examples.

Some one asked Professor Michelson why he spent so much time in measuring the velocity of light, and he replied: "Because it is such good fun." No keener joy is probably ever experienced than that which accompanies original discovery.

The photo electric effect is just another of the discoveries in pure science of today which are becoming the tools of the workshop and the laboratory of tomorrow.

FORM AND FORMULA IN PHYSICS TEACHING

By Karl A. Zeller,

Central High School, Columbus, Ohio

Many high school students do not elect Physics because of their impression that Physics requires an expert knowledge of mathematics and is a "hard subject."

The tragedy about our mathematics teaching is that often our best students cannot use it. Algebraic equations, geometric reasoning, trigonometric functions as such, many of them handle with reason, understanding and ease. But place these same students in a Physics class room, with different situations, "text" and teacher and something snaps.

A working knowledge of the four fundamental principles of arithmetic, simple fractions, percentage, decimals, ratio and proportion, the algebraic equation, graphs, simple geometric constructions, the fundamental theorems of triangles, parallelograms and the circle, is the most necessary.

The ability to use the above operations should not be too much to expect of the student, who has been well taught in eighth, ninth and tenth grade mathematics.

Formulas are not dead, abstract statements, into which given values are substituted and the "unknown" found—they are rather live friends, full of power and action, when in the hands of one who knows how and when to put one to work.

Very few formulas in Mathematics and Physics should be given to students to use, until they have been derived by teacher and pupil, until the relationship between the various functions are thoroughly understood and recognized, as expressed in the formula.

Formulas express a very definite relationship between the various factors of a mathematical condition or a Physical Law. The presence of dependent, constant and variable *can* be shown, and their relation expressed in terms of formula. Since ratio and proportion so often occur in Chemistry and Physics, they should be understood as an expression of relationships, which lead to the formulation of scientific laws. Some formulas can be derived from definition, some from actual experiment, others from those previously found. One cannot expect children to have learned how to use formulas in Physics from any previous experience with them in Algebra.

One must become acquainted with formulas through use, not memory. The mind should be too active with thinking to be crowded with material that is not in running order. It is of course quite important that the student be able to formulate a clear, clean-cut statement, that expresses the relations *in* the formula.

Boyle's Law should be so discussed that the group get the conception of pressure as due to the molecular energy of the gas, which causes a molecular bombardment of each other, as well as the sides of the containing vessel. Then the inverse ratio or relation between the volume of a given gas, under *constant* temperature, and the pressure that results, can be intelligently understood.

Here is where the work in the laboratory should link up with the text book study and class room discussion. The laboratory becomes a work shop, not a play room.

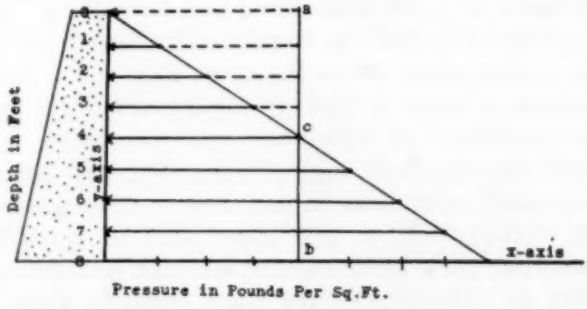
From the measurements taken and the calculations made, with Boyle's Law apparatus, in the laboratory, the student finds, for four or five readings that VP=for example 1578,

$V_1P_1=1580$, $V_2P_2=1584$ etc. Here comes the real value of the experiment. Surely he can reason that since in each case the product of the volume by the corresponding pressure is a constant, then $VP=V_1P_1=V_2P_2$. He must now put to use his *previous experience* with ratio and proportion. If either "pair" can be made the "extremes" or "means" of a proportion, then $VP=V_1P_1$ may be written $V:V_1::P_1:P$, and he is ready to formulate a physical law. With it all he has gained *for himself*, or if you please proven *for himself*, a knowledge of the facts.

In so far as the laboratory is a place where he gets these real conceptions of the subject, just so far is the place of the laboratory in the curriclum justified.

One more example—The lateral pressure exerted by water, on a lock gate or dam, is shown, in the relation expressed in the formula $P=\frac{Ahd}{2}$, and text books stop with the stating of the formula. The mere statement of average pressure, to my mind, is not sufficient. If the teacher will develop this formula by "graph," so that his class will understand and see its beauty, it will become a potential power ready for use. What total force is exerted on a dam 8 feet high and 30 feet long, when the water back of it stands 8 feet deep?

The graph-force diagram can be drawn to any convenient scale. The units on the x-axis represent 62.5 pounds pressure. On the y-axis one foot, depth of water.



The horizontal lines representing the pressure in pounds per sq. ft. are drawn first. When the ends of these lines are connected, the resulting straight line graph indicates the relation between pressure per sq. ft. and water depth.

The pressure for any depth can be "picked off" the graph.

Draw a line ab through c, perpendicular to the x-axis. It will be found that the pressure lines, to the right of ab, will just fit in and fill the gap in the pressure lines to the left of ab. This can be checked by showing the two triangles congruent.

Now the graph-force diagram shows all pressure lines equal, and the average pressure the same as that indicated by the line 4c. From the graph the value of this "average line" is 4 units or 250 pounds per sq. ft. This average pressure can be shown to be equal to the ½ hd of the formula. Hence the total force exerted is equal to the area in square feet times the average pressure per sq. ft., from which the relation, total force $P=\frac{Ahd}{2}$ is readily obtained.

These two illustrations are sufficient to present my plea. The subject allows many similar opportunities.

One can hardly feel that the fault for the present High School Physics situation lies wholly with the teacher. It may be due to some artificial standard set up, some arbitrary test that must be passed or perchance to the number of students who must be *turned out* each year. And so the teacher reacts to what he feels he *must* do.

Even in the face of such, students should be taught how to study and how to use the material in text books. They should learn to think of their text book as a reference book to which they can turn for help in time of trouble, not as a mass of material to be memorized and forgotten. Too frequently children are held so rigidly to the text wording that to them memorizing seems the only way out. Manipulations become a form, a type, formula mechanical and lifeless, the "solution" of which is puzzle-like in its working. Organized thought and logical reasoning are impossible. Why not allow your class to use their text books during a problem examination, or any other kind of a test? Who cares whether they have memorized Herron's formula, or any other as ridiculous? We want them to know rather where and how to use it.

Experience in laboratory *should* develop a desire for observation, accuracy, relationships, truth, and the expression of their findings in terms of a Law. Let us teach our

students how to use the knowledge placed at their hand, and stop forcing them to memorize it. Then will Science and Mathematics become properly related in the minds of our students, and both teacher and student will enjoy their beauty because they lead to straight thinking and clear reasoning.

Science is not connected alone with text book, class room and laboratory, but with all the outside world.

We know that it is what we teach, not how much that counts, that more time must be given to quality, less to quantity, more to thinking, less to memorizing, more to fundamentals and their mastery, less to form. Can we meet the challenge?

BOOK REVIEWS

Unit Mastery Arithmetic, by John C. Stone, Professor of Mathematics, State Teachers College, Montclair, New Jersey and Clifford N. Mills, Professor of Mathematics, State Normal University, Normal Illinois. Illustrated by Marion C. Allen. Primary, ix+493 pages, price 50 cents. Intermediate x+487 pages, price 86 cents. Advanced, viii+520 pages, price 88 cents. 13x19 cm. 1932. Benj. H. Sanborn and Company, 221 East 20th Street, Chicago, Illinois.

The authors of this series of arithmetics need no introduction to teachers of elementary and secondary mathematics. They have national reputations as authorities in the field of mathematical education. In the production of this series they have made use of the extensive research which has been carried on during recent years by themselves and numerous other workers in the teaching of arithmetic.

There are three books in the series. Each book—the first beginning with the third grade—includes material for two grades.

We find the work of each grade is divided into ten units. Each unit is designed to develop closely related skills. Each page is a sub-unit that develops a specific skill, or gives practice on different skills. The tenth unit contains practice material or tests on all the skills.

The authors claim that the books are so carefully and scientifically designed that to get the best results the development and practice pages up through the sixth grade should be followed page by page. The pupil is to master each page before leaving it for the next. In the upper grades, although enough practice material is given in each unit for maintaining and extending former skills, the emphasis is placed on quantitative thinking as related to life experiences. A great variety of topics is offered. To indicate the scope of this material we enumerate the headings of a few units. They are: Building, Heating, and Lighting our Homes; Home and Community Problems; Statistical Graphs; Geometry in Nature and Design; Practical Applications in Geometry—The Formula; Protecting Losses through Insurance; Civic Enterprises and Taxes; Ratio and Proportion—Indirect Measurement.

Each book is attractively illustrated. Each is written in the language of children and appeals to their interests. We feel that children should get a great deal of pleasure out of arithmetic when books of this type are placed in their hands. J. M. Kinney.

Recent Advances in Physical Chemistry by Samuel Glasstone, Lecturer in Physical Chemistry, University of Sheffield. First edition. Pages vii+464 plus index of 6 pages. 14.5x20.5x3 cm. 32 illustrations. Cloth. 1931. Blakiston's Son & Co. Price $3.50.

This book was written for the chemist who is desirous of keeping abreast of modern developments in the field of physical chemistry and yet does not have the time nor opportunity to read all of the literature on the subject. Also, those students in Universities who do not find modern developments as yet incorporated in general texts of physical chemistry will find here a critical discussion of the more important topics. The following eleven topics are discussed in detail: "Electronic Theory of Valency," "The Parachor," "Dipole Moments," "Molecular Spectra," "Homogeneous Gas Reactions," "Photochemical Reactions," "Properties of Surfaces," "Heterogeneous Catalysis," "Solubility," "Strong Electrolytes," and "Acid-Base Catalysis."

At the end of each chapter one finds many references to the literature.

Every student of theoretical chemistry will wish to examine this book. Druley Parker.

Qualitative Analysis by Olin Freeman Tower, Hurlbut Professor of Chemistry in Adelbert College of Western Reserve University. Sixth edition, revised. Pages xv+83+appendix of 8 pages. 16x23.5x1 cm. Cloth. 1932. Blakiston's Son & Co. Price $1.50.

This book does not pretend to be an exhaustive treatise on the subject of qualitative analysis but is only intended for a one-half year course. The theory is treated in the first fourteen pages, the treatment being qualitative rather than quantitative in nature.

Previous to the beginning of a systematic study of the groups, directions are given for a series of preliminary tests upon the cations as a whole.

The text is so organized that the directions for the precipitation and analysis of each group occupies the left hand page while the right hand page contains notes in regard to the precipitation and analysis of the group in question.

Eight pages are devoted to the preparation of the solutions used in the analysis. Teachers of qualitative analysis in liberal arts colleges should examine the book. Druley Parker.

The First Year of Chemistry by John C. Hessler, Professor of Chemistry, Knox College. First edition. Pages xii+545+appendix of 15 pages. 14x20x3 cm. Many illustrations. Waterproof cloth. 1931. Sanborn & Co.

The purpose of this book as stated by the author is (1) to provide a foundation for further work in chemistry and (2) to justify the science to those who have only one school year in which to become acquainted with it.

Apparently the author has succeeded as well as most authors of high school texts. The subject matter is treated in the traditional manner. Atomic structure in connection with valence is not used but is set apart in a chapter by itself and not used afterwards.

The chapter on gases and the solving of problems involving the law of Boyle and of Charles is excellent in that the solution of the problems is approached from the common sense standpoint and not by the use of formulas.

The summaries at the end of the chapters are thorough and the learning exercises are ample.

In the chapter on valence, fifty-four different elements and radicals are listed but the student is not given any guidance as to which of these he will find of the most use in writing the formulas which he will encounter.

A chapter is devoted to the writing of chemical equations in a very thorough manner; however, the relation between the molecular formula of a gas and its molar volume is not developed in connection with the solving of problems. Druley Parker.

Laboratory Exercises to Accompany the Brownlee-Fuller-Hancock-Sohon-Whitset Chemistry by the same authors. Revised loose-leaf edition. Pages ix + 271 + appendix of 9 pages. 22x26.5x2 cm. Line drawings and half tone illustrations. 1931. Paper. Allyn & Bacon.

Being of the interlinear loose-leaf type of manual, this book will interest those teachers who prefer to have their reports of experiments brief and to the point.

Directions are given for eighty-four experiments. In the preface these are divided into three groups: A, B and C. The A group experiments are fundamental in nature, those of group B are quantitative, while those of group C deal with the practical applications of chemistry.

The illustrations of apparatus assemblies are half tones of rather poor quality.

At the end of the experiments are four new type examinations covering the material in the experiments. Teachers using the manual would no doubt find these of value.

The appendix contains the physical constants of the important elements, physical constants of the common gases, table of solubilities, degree of ionization of certain compounds, etc. Teachers interested in securing a manual containing the fundamental exercises and one which permits of ease of administration will be interested in examining this work. Druley Parker.

For an Effective Program in Functional Algebra

BETZ

ALGEBRA FOR TODAY

A First Course based on six central objectives. The language and ideas of algebra, the formula, the equation, the graph, the fundamental principles and processes, and problem-solving. Seventeen chapters, the first seven presenting a compelling motivation for the functional program.

A Second Course flexible enough for a maximum or a minimum course. Optional topics for speedier groups. Adequate emphasis on the cultural side of mathematics.

GINN AND COMPANY

BOSTON NEW YORK CHICAGO ATLANTA DALLAS COLUMBUS SAN FRANCISCO

Please Mention School Science and Mathematics when answering Advertisements.

Report of a Study of the Secondary Curriculum, by a committee of Preparatory School Educators with Mr. Howard T. Smith, Executive Secretary of the Secondary Education Board, Milton, Mass., as Chairman. pp. 237. 15x22.5x1.25 cm. Paper. 1932. Price 50 cents.

The Secondary Education Board, whose committee publishes this report, is composed of some 140, more or less, of our better private academies and preparatory schools. The study presented in the report is the result of three years work on the part of the committee. More than 50 teachers associated with 40 schools took part in the study. Subcommittees studied some ten subject fields. The Carnegie Corporation helped finance the project.

One of the chief aims was to liberalize the curricula of the schools. Another was to try to plan to minimize artificial divisions between and within subjects. The several special reports are excellently presented and detailed curricula are given save in those subjects, which, like chemistry, have had the benefit of previous thorough-going studies, such as that of the Committee of the American Chemical Society on "A Standard Minimum High School Course in Chemistry."

Educators generally and especially those in secondary education will want to see and study this report. Address Secondary Education Board, Milton, Mass. Frank B. Wade.

Mathematical Nuts by Samuel I. Jones, Assistant Secretary and Treasurer of the Life and Casualty Insurance Company, Nashville, Tenn., and formerly Professor of Mathematics in David Lipscomb College, Nashville, Tenn. Cloth. Pages x+340. 12.5x19 cm. 1932. Samuel I. Jones, Life and Casualty Bldg., Nashville, Tenn. Price $3.50.

Here is the book in answer to your question, "Where can I find material for my problem solvers?" It is a companion to *Mathematical Wrinkles* by the same author. *Mathematical Nuts* consists of problems of all kinds: difficult ones, easy ones; tricks, catches, puzzles, straight mathematics; arithmetic, algebra, geometry, trigonometry, analytics, calculus, physics; problems that will keep Willie and Dad together for an entire evening; problems that will keep the club in continuous session. Here are a few samples:

"This and that and a half of this and that is what per cent of three-fourths of this and that?"

"With six matches form four equilateral triangles, the side of each being the length of a match."

"To what height must a man be raised above the earth in order that he may see one-sixth of its surface?"

"Suppose that when an orchestra has nearly finished a performance, an observer should move away from the orchestra with a velocity twice that of sound. Describe his relation to the sounds previously executed by the orchestra."

A section is devoted to "cracking the nuts"—solutions to some of the problems. "Nut Kernels"—answers are also given. Have a little fun in your class every day. Even the dead pupils will come to life. Pupils who must have a formula for each problem will actually begin to think if you give them one of these brain teasers that just seem to be based on common sense. You may then be able to show that equations and formulas are also common sense. Every teacher of mathematics or physics should have this book.

G. W. W.

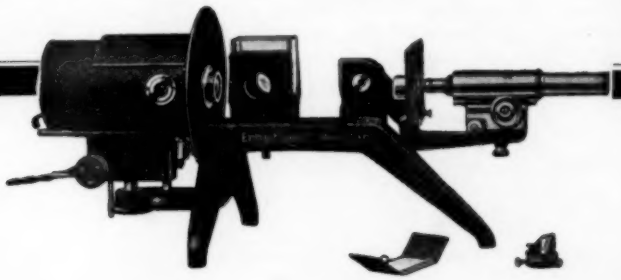
Useful Science by Henry T. Weed, Head of the Science Department Girls Commercial High School, Brooklyn, New York and Frank A. Rexford, Director of Civics, City of New York Book One. Cloth. Pages xvi+222. 12.5x19 cm. 1931. The John C. Winston

Simplify the Lecture

by projecting enlarged images of microscopic specimens on a screen

the LEITZ "*xb*" MICRO-PROJECTOR

is easy to operate and gives perfect results



Demonstrations and lectures before groups of students are made infinitely more interesting and effective by projecting the subject of the discussion on a screen. For this purpose the Leitz Micro-Projector "xb" is indispensable, not only for its scientific accuracy and dependability, but also for its extreme convenience and simplicity of operation.

Here are its outstanding features:

1. **Compactness—Portability.** Measures 29 inches long by 13½ inches in height. The weight including the arclamp is only 20 lbs.

2. **All Units Permanently Adjusted.** The apparatus is supported by a tripod of cast iron and all individual units are cast as a permanent part of the base. All parts which are a factor in the optical alignment are fixed at the correct distance, and no adjustment to height is required. The optical axis has been accurately and permanently gauged and set at the factory. This construction eliminates the necessity of trained operators, and assures perfect results without difficulty or loss of time.

3. **Automatic Arclamp,** feeding the carbons by clockwork mechanism, supplies concentrated light and high candle power.

4. **Standard Compound Microscope Unit** provided with rack and pinion for coarse focus as well as micrometer screw for fine adjustment.

5. **Safety Device** protecting both objectives and specimens against injury.

Write for Pamphlet No. 1161-81

E. LEITZ, Inc.

60 East 10th Street New York, N.Y.

Company, 1006-1016 Arch Street, Philadelphia, Pa. Price $1.08.

This is the first book of a series planned for junior high school use. The authors state that they "have attempted to make the study one of self-questioning on the part of the pupil." In the first chapter the pupil is told the value of experiment and how experimentation is carried on. The second chapter describes a typical experiment and gives the report. The remainder of the book consists of twenty-six short chapters, each teaching the essentials of a science topic associated with daily life. Many of the chapters include directions for performing an experiment which will enable the pupil to answer an important question proposed. Some of the experiments may be done at home. Most of them are simple and qualitative but some are quantitative: e. g. determining the percentage of oxygen in the air, and determining the percentage of water in a potato. In general the book is well designed to accomplish the aim of the authors, but in cultivating a spirit of inquiry any textbook must receive the support of the teacher. For the good teacher the book has told too much about some topics, so much that the suggested experiment need not be done; the pupil can get all the answers by reading the discussion. The teacher with insufficient preparation needs all the help given. G. W. W.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON,
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS OF PROBLEMS

Editor.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many times, a good solution is received, but poorly arranged and no India-ink figure given.

LATE SOLUTIONS

1185, 1186, 1198. *Leo Aroian, Fort Collins, Colo.*
1198. *Guy Berry, Fort Collins, Colo.*
1200, 1204. *Sudler Bamberger, Harrisburg, Pa.*
1205. *Proposed by Albert Whiteman, Philadelphia, Pa.*

Show that any number of the form X^n is the sum of consecutive odd integers.

Solved by H. L. Krall, Providence, R. I.

The solution is simply a matter of demonstrating the identity:

$$X^n = (X^{n-1}-X+1)+(X^{n-1}-X+3)+\cdots+(X^{n-1}+X-3)+(X^{n-1}+X-1)$$

We see at once that each term of the series is odd, the common difference is 2, and the number of terms is X. Thus the sum, S, is

$$S=\frac{X}{2}(X^{n-1}-X+1+X^{n-1}+X-1)=\frac{X}{2}(2X^{n-1})=X^n.$$

Note: In the solution submitted by L. Alvarez, Chicago, attention was called to an exception, namely n must be an integer greater than 1. Thus $2^1=(2^0-2+1)+(2^0+2-1)=0+2$.

Other examples:

The Master Instrument
for Classroom and Laboratory

Group demonstrations of electrical tests are easier when you use Jewell Master Electrical Measuring Instruments.

Their long, easy-to-read scales, knife-edge pointers, and anti-parallax mirrors not only make it easier for the student to follow your explanations, but also allow you to handle much larger student groups.

Jewell Master Instruments are available in A. C., D. C., and thermocouple types, with scale ranges to meet every measuring need of the school laboratory. Combination instruments having both current and voltage measuring scales are especially adapted to school use.

Years of uninterrupted service are assured by the rugged construction of Jewell Master Instruments. Molded bakelite cases and non-shatterable glass scale windows protect their sensitive movements.

Why not add the Jewell Master Instrument Catalog to your library? Write for your copy today.

Jewell Electrical Instrument Company

4 Haynes Avenue, Newark, N. J.

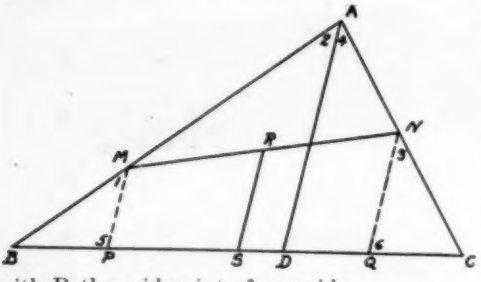
32 YEARS MAKING INSTRUMENTS

JEWELL

$$2^3 = (2-2+1)+(2+2-1) = 1+3$$
$$3^3 = (3-3+1)+(3-3+3)+(3+3-1)$$
$$= 1+3+5$$
$$6^4 = 211+213+215+217+219+221.$$

Also solved by W. E. Buker, Leetsdale, Pa., L. Alvarez, Chicago, Ill., and the Proposer.

1206. *Proposed by A. Strunk, Paterson, N. J.*



In $\triangle ABC$, AD bisects $\angle BAC$; M is a point on AB, and N a point on AC, such that BM = CN; R is the mid-point of MN, S the mid-point of BC. Prove that AD and RS are parallel.

Solved by W. E. Batzler, Battle Creek, Mich.

1. Construct MP and NQ $\parallel$ AD. Then MPQN is a trapezoid with R the mid-point of one side.

2. By $\parallel$ lines $\angle 1 = 2$, $\angle 3 = \angle 4$, and since $\angle 2 = \angle 4$, $\angle 1 = \angle 3$. Also $\angle 5$ and $\angle 6$ are supplementary.

3. In $\triangle$s BMP and NQC, BP = QC. (It can be easily proved that, "If two triangles have an angle and a side respectively equal and the angles opposite the equal sides are supplementary, then the sides opposite the equal $\angle$s are equal.)

4. By substraction PS = SQ and therefore RS $\parallel$ NQ and AD. (A line connecting the mid-points of the non-parallel sides of a trapezoid is parallel to the other two sides.)

5. Hence RS $\parallel$ AD.

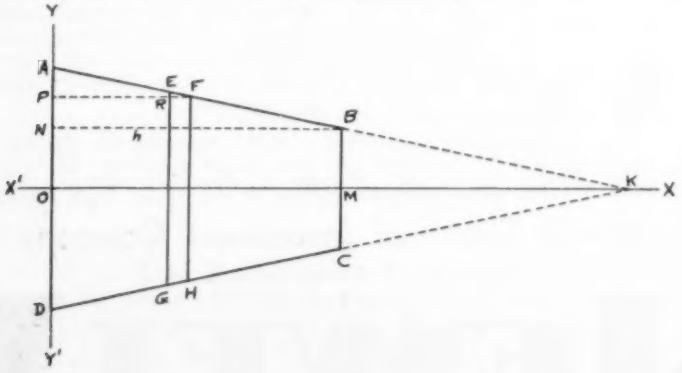
Note: The Editor will submit for high school students the theorem mentioned in "3" above as a problem for solution in the next issue.

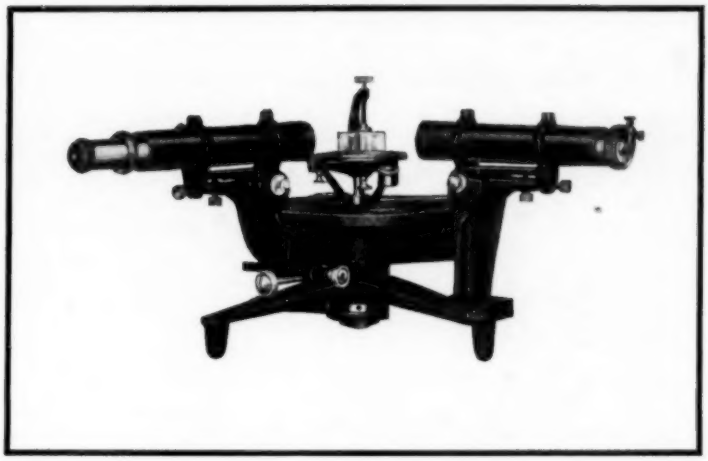
Also solved by Charles W. Trigg, Los Angeles, Calif.; Violetta Land, Sparta, Ill.; A. J. Patterson, Wheeling, W. Va.; M. Grossman, New York City, and W. E. Buker, Leetsdale, Pa.

1207. *Proposed by Harry Frye, Tullahoma, Tenn.*

I have a plot of ground in the shape of a trapezoid. One base is twelve feet long and the other is six feet long. The two sides are each one hundred and forty feet long. I wish to build a walkway through this plot of ground parallel to the bases, with one edge of the walkway passing through the center of gravity of the plot and the other edge dividing the plot of ground into two equal areas. Just where and how wide shall I build this walkway?

Solved by Charles W. Trigg, Los Angeles, Calif.





For

Inexperienced Students

A RUGGED SPECTROMETER

INEXPERIENCED students unavoidably give a spectrometer rough usage. For this reason the Spencer Medium Spectrometer is one of the best for students' use—its ruggedness protects its inherent precision against such rough usage.

It is built low and compact. The central bearings are massive enough to stand ordinary abuse and still function perfectly. The telescope and collimator supports hold them in perfect alignment even when subjected to constant knocks and bumps.

The optics are of the finest quality. The adjustments are made with the same skill and care that go into the fine adjustment of a microscope.

We'll gladly send you full and complete information on this Spencer Medium Spectrometer. Write for it today!

BRANCHES: New York, Chicago, San Francisco, Boston, Washington, Minneapolis, Los Angeles

PRODUCTS: Microscopes, Microtomes, Delineascopes, Visual Aids, Optical Measuring Instruments

Spencer Lens Company

BUFFALO NEW YORK

Please mention School Science and Mathematics when answering Advertisements.

In the figure, extend AB and DC to meet at K. Through K draw XX′ ⊥ BC and AD. Extend AD to Y and Y′. FH is the line passing through the center of gravity. Draw BN and FP ⊥ AD. Let BN = h.

Since ABCD is symmetrical with respect to the X-axis, the center of gravity falls on OM. The abscissa of the center of gravity.

$$\bar{x} = \frac{\int_o^h \int_{-(6-\frac{3x}{n})}^{6-\frac{3x}{n}} x \, dy \, d \, x}{\int_o^h \int_{-(6-\frac{3x}{n})}^{6-\frac{3x}{n}} dy \, d \, x} = \frac{4}{9} h$$

Since △AFP ∽ △ABN,

$$\text{AF} : \frac{4}{9} h = \text{AB} : h$$

(1) $\text{AF} = \frac{4}{9}\text{AB} = \frac{4}{9}$ of $140 = 62.222$ ft.

△BCK and △ADK are ∽ , so that

(2) $$\frac{\triangle \text{BCK}}{\triangle \text{ADK}} = \frac{\overline{\text{BC}^2}}{\overline{\text{AD}^2}} = \frac{6^2}{12^2} = \frac{1}{4}.$$

(3) Then $$\frac{\triangle \text{BCK}}{\text{BCDA}} = \frac{1}{3} \text{ or } \frac{2}{6}.$$

EG when drawn || AD to divide BCDA into equal areas will form △ EKG ∽ △ AKD, so that

$$\frac{\triangle \text{EKG}}{\triangle \text{AKD}} = \frac{5}{8} = \frac{\overline{\text{EK}^2}}{\overline{\text{AK}^2}}$$

(4) $\therefore \text{EK} = \text{AK}\sqrt{\frac{5}{8}} = 280\sqrt{\frac{5}{8}}$

$\text{AE} = 280 - 280\sqrt{\frac{5}{8}} = 58.632$ ft.

(5) $\text{AF} - \text{AE} = \text{EF} = 3.59$

In △ABN, $h = \sqrt{\text{AB}^2 - \text{AN}^2} = (140)^2 - 3^2$.

△REF ∽ △ABN.

$\text{RF} : \text{EF} = h : \text{AB}$

$$\text{RF} = \frac{h\,(\text{AF} - \text{AE})}{\text{AB}} = \frac{3.59\sqrt{(140)^2 - 3^2}}{140} = 3.589 \text{ ft.}$$

Consequently, to construct the desired walkway, which will be 3.589 feet wide, measure along each of the two sides from the longer base distances of 58.632 feet and 62.222 feet and connect these points.

1208. *No solution received.*

1209. *Proposed by A. J. Patterson, Wheeling, W. Va.*

Prove that the difference of the squares of any two numbers divided by twice the greater gives a quotient which when squared and added to the square of the lesser number gives a perfect square.

Solution by Kenneth P. Carlson, Kearney, Neb.

Suppose the numbers are a and b $(a > b)$.

Prove that $\left(\frac{a^2 - b^2}{2a}\right)^2 + b^2$ is a perfect square.

Solution: Simplifying the above, we find that

Within 20 Days of Publication
USEFUL SCIENCE
Book Two
was adopted by the
STATE OF FLORIDA
for exclusive basal use
for eight years

❖ ❖ ❖

USEFUL SCIENCE
Weed and Rexford
BOOK ONE . . GRADE 7
BOOK TWO . . GRADE 8
BOOK THREE,
IN PREPARATION
Examination copies sent on request
with a view to adoption

❖ ❖ ❖

THE JOHN C. WINSTON CO.
CHICAGO PHILADELPHIA ATLANTA

General Science
Laboratory
Sheets

Adaptable to:

1. **Any basal text.**
2. **Any course of study.**
3. **Minimum laboratory equipment.**

Write your name and address in the margin and return this advertisement to us in an envelope for a copy.

You may obtain similar manuals in physics, chemistry, applied chemistry, physiography and biology, by addressing the

GLOBE BOOK COMPANY
175 Fifth Avenue New York, N. Y.

HART'S
MODERN JUNIOR
MATHEMATICS
BOOKS I, II, III

Consider these points:
Arithmetic, algebra, and geometry successfully unified . . . Unit presentation . . . Diagnostic tests and remedial instruction precede each new topic; mastery tests and drills follow . . . Courses for *X*, *Y*, and *Z* groups . . . A complete teaching manual for each book.

D. C. HEATH
and COMPANY
Boston, New York, Chicago, Atlanta,
San Francisco, Dallas, London

By R. R. Ramsey, Prof. of Physics, Ind. Univ.
Experimental Radio
128 BASIC EXPERIMENTS
Using ordinary Physic apparatus and Radio equipment. No high-priced pieces.
If you want your students to know radio (and physics) let them make laboratory measurements.
Measure and know!

The
Fundamentals of Radio
Radio explained from a physical standpoint. Explains why you twist the knobs.
Filters; Decrement; Tube Load; Decibels; Balanced Load; Attenuators explained in no other book.
Read and learn!
Price Fundamentals, $3.50. Experimental, $2.75. Postpaid

Ramsey Publishing Co.
BLOOMINGTON, IND.

$$\left(\frac{a^2-b^2}{2a}\right)^2+b^2=\frac{a^4-2a^2b^2+b^4}{4a^2}+b^2=\frac{a^4-2a^2b^2+b^4+4a^2b^2}{4a^2}=$$

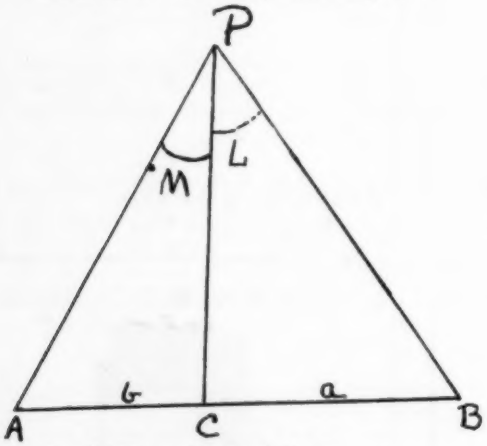
$$\frac{a^4+2a^2b^2+b^4}{4a^2}=\left(\frac{a^2+b^2}{2a}\right)^2, \text{ a perfect square.}$$

Also solved by Ruth Harrison, Norfolk, Va.; Bernard Fehring, St. Nazianz, Wis.; Mack Tucker, Bremen, Ind.; Samuel M. Cohn, Philadelphia, Pa.; L. Alvarez, Chicago; Charles W. Trigg, Los Angeles, Calif.; Leo Adasiewiez, Champaign, Ill.; George L. Royce, Racine, Wis.; Albert Whiteman, Philadelphia, Pa.

1210. *Proposed by Leo Aroian, Fort Collins, Colo.*

To chart the position, P, of a sunken wreck three points A, B, C, in a straight line are marked on the shore and an observer at P in a small boat measures the angles APB, and BPC. Show how to find AP, BP, and CP.

Solved by W. E. Buker, Leetsdale, Pa.



Let $BC=a$; $CA=b$; $\angle BPC=L$; $\angle CPA=M$; $\angle BPA=N=L+M$.

By the law of sines,

$$\frac{a}{\sin L}=\frac{PC}{\sin B}; \frac{b}{\sin M}=\frac{PC}{\sin A} \quad (1)$$

$$\therefore \frac{a \sin B}{\sin L}=\frac{b \sin A}{\sin M} \quad (2),$$

from which $\frac{\sin A}{\sin B}=\frac{a \sin M}{b \sin L}$

Hence by the theory of proportion,

$$\frac{\sin A-\sin B}{\sin A+\sin B}=\frac{a \sin M-b \sin L}{a \sin M+b \sin L} \quad (3)$$

But, from trigonometry,

$\sin A \pm \sin B = 2 \sin \frac{1}{2}(a \pm b) \cos \frac{1}{2}(a \mp b)$

Hence, (2) may become

$$\frac{\tan \frac{1}{2}(a-B)}{\tan \frac{1}{2}(a+B)}=\frac{a \sin M-b \sin L}{a \sin M+b \sin L} \quad (4)$$

Now, since $\frac{1}{2}(A+B)=90°-\frac{N}{2}$, (5)

We are enabled by (4) to compute $\frac{1}{2}(A-B)$; from which by addition and subtraction with (5) we can find A and B.

By means of (1) we compute PC (the two ways afford a check) and find PB and PA by applying the law of sines to triangle PAB.

Also solved by Charles W. Trigg, Los Angeles, Calif.; and R. T. McGregor, Elk Grove, Calif.

FOR HIGH SCHOOL STUDENTS

As suggested in the December issue, the Editor would like to enlist the interest of high school students in the easier problems proposed for solution. For those high schools whose classes in mathematics or mathematical clubs or students as individuals make noteworthy contribution to this department the Editor will give honorable mention. Teachers

K & E
Slide Rules

are used almost exclusively at leading institutions of learning. They have an established reputation for fine quality and accuracy. Our manuals make self-instruction easy for teacher and pupil.

Made in U. S. A.

Keuffel & Esser Co.
of N. Y.
520 South Dearborn St.,
CHICAGO, ILL.

Send for catalog

PLANE GEOMETRY

ELIZABETH B. COWLEY, Ph. D.

EXERCISES. Each theorem, with a few exceptions, is followed by exercises which either assist the student in the mastery of that theorem or prepare for work to follow. The first few exercises of a set are simple in order to assist the student in applying the theorem. Simple exercises also serve to clarify geometric concepts. Emphasis is on the basic propositions. There are more than 1500 exercises of various types. Some require proof. Some are completion exercises. Some involve numerical calculations or algebraic work. Many of the exercises are practical problems dealing with situations within the actual experience and interests of boys and girls of high school age.

Silver, Burdett and Company

New York Newark Boston Chicago
San Francisco

WE COVER THE EARTH!

School Science and Mathematics

is read by subscribers in every state of the Union, all provinces of Canada, and thirty-three foreign countries.
It is owned by teachers, managed by teachers, and edited by teachers.

For thirty years teachers of Mathematics and Science all over the world have depended upon us to bring to them the first news of new books and apparatus.

RECENT ARTICLES

1. **Mathematics Recreational Program.**
2. **How to Study Algebra.**
3. **Square Root in 8th Grade Arithmetic and 9th Grade Algebra.**
4. **An Outline of High School Calculus.**
5. **Co-operative Mathematics Helps Introduce the Formula.**
6. **Science Clubs: a Bibliography.**
7. **The Project Method in High School Biology.**
8. **A Unit in 9th Grade Biology.**
9. **A Unit on the Metallurgy of Iron and Steel.**
10. **A Contract in Chemistry: Calcium.**

Subscribe Now.

Back numbers 40c, or more if rare. For any volume from 1903 to 1930 write for quotation.

Price $2.50 a Year Foreign Countries $3.00

SCHOOL SCIENCE and MATHEMATICS

Published by
CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS INCORPORATED
Nine issues a year. No numbers published for July, August and September
3319 N. 14th St., Milwaukee, Wisconsin

are urged to make report to the Editor of extensive study as suggested above.

HONORABLE MENTION

1209. *Leetsdale (Pa.) High School.*

PROBLEMS FOR SOLUTION

1223. *Proposed by Gunther Wunsche, Dresden, Germany.*

For any triangle prove that four times the sum of the squares of the medians equals three times the sum of the squares of the sides.

1224. *Proposed by P. H. Nygaard, North Central High School, Spokane, Wash.*

The approximate location of Rome is long. 12° 30′ east, lat. 42° north and of Chicago is long. 88° west, lat. 42° north. (a) What is the distance in statute miles from Chicago to Rome if a due east course is followed? (b) What is the distance in statute miles along the great circle course? (c) What is the latitude of the point farthest north along the great circle course? (Assume that the earth is a sphere with a radius of 3956 miles.)

1225. *Proposed by Henry Schroeder, Ruston, La.*

A circle of radius a moves with its center on the circumference of an equal circle, and keeps parallel to a given plane which is perpendicular to the plane of the given circle. Find the volume of the solid it will generate. Use rectangular coordinates and single integration.

1226. *Proposed by M. C. Erwin, Reynolds, Ind.*

The distances from a point to the three nearest corners of a square are 1 inch, 2 inches, and $2\frac{1}{2}$ inches respectively. Construct the square (Two Solutions).

1227. *Proposed by Samuel M. Cohn, Philadelphia, Pa.*

Given the trapezoid ABCD, in which the top base $CD = \frac{1}{2}$ the bottom base AB, and the sum of $\angle BAD$ and $\angle ABC = 90°$. Prove that the square of the bottom base ($\overline{AB}^2$) is equal to four times the sum of the squares of the two sides ($4(\overline{AD}^2+\overline{BC}^2)$).

1228. *Proposed by Arthur J. Kavanagh, Washington, Conn.*

ABCD is a parallelogram. E is on AB; F is on CD. AF intersects DE at G. BF intersects CE at H. GH cuts AD at K, and BC at M. Prove AK = MC, by the methods of ordinary plane geometry.

BOOKS RECEIVED

The Teaching of Elementary Mathematics by the late Professor Charles Godfrey, formerly Senior Mathematical Master at Winchester College and Head Master of the Royal Naval College, Osborne, and A. W. Siddons, late Fellow of Jesus College, Cambridge; Senior Mathematical Master at Harrow School. Cloth. Pages 11+322. 12.5x20 cm. 1931. University Press, Cambridge, London. The Macmillan Company, New York. Price $2.50.

Children of a Star by Julie Closson Kenly and illustrated by Henry C. Kenly. Cloth. Pages x+241. 13x20.5 cm. 1932. D. Appleton and Company, 35 West 32nd Street, New York. Price $2.50.

Living Geography, Book One by Ellsworth Huntington, Yale University, C. Beverley Benson, formerly of Cornell and Purdue Universities, and Frank M. McMurry, Teachers College, Columbia University. Cloth. Pages vi+346. 335 illustrations. 28 colored maps. 19x25.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.20.

Living Geography, Book Two, by Ellsworth Huntington, Yale University, C. Beverley Benson, formerly of Cornell and Purdue

SOMETHING NEW

For

Superintendents—Principals—Teachers
Math. and Science Clubs

Just Off The Press **Math. Nuts** Useful and Entertaining **Math. Wrinkles** 1930 Ed. Rev. and Enl.

This work is indispensable to the teacher of Mathematics and Physics. It contains more than 700 solutions and over 175 illustrations. You will prize this work very highly.

Price Postpaid—$3.50

The fifth edition is almost exhausted. This beautiful volume contains everything necessary for the Mathematics Club—required by either teacher or student.

Price Postpaid—$3.00.

These are companion Source Books. Each contains an abundance of recreations.

What Others Say—(Mathematical Wrinkles).

"Your Mathematical Wrinkles which I received a few weeks ago is a classic in its field. It is as stimulating as it is profitable—a veritable 'Whetstone of Witte.'

"Please put me down for a copy of Mathematical Nuts and mail it to me as soon as it is off the press."

Dated December 5, 1931. (Signed) M. C. Erwin, Head Math. Dept., Reynolds High School, Reynolds, Ind.

"A most convenient handbook whose resources are practically inexhaustible. We cordially recommend the volume as the most elaborate, ingenious and entertaining book of its kind that it has ever been our good fortune to examine."—*Education, Boston, Mass.*

These books are attractively illustrated and beautifully bound in half leather. See that copies are in your library. Forward your orders today.

If ordered direct a copy of each will be sent on receipt of only $5.00

S. I. JONES, Author and Publisher

Life and Casualty Bldg., Nashville, Tenn.

Attention, Biology Teachers

Our latest reprint is entitled

Some Lessons About Bees

By C. P. WEBSTER

Allegheny Vocational School, N. S., Pittsburgh, Pa.

A 32-page booklet by an expert on bees; it teaches the mysteries of bee life. Long enough to cover essentials; short enough for a unit, or project. Well illustrated. Valuable for supplementary work. Get a set of 30 for your library.

Price—40c; in 15 lots, @ 30c; in 30 lots, @ 25c.

Order prepaid, net; prompt delivery

SCHOOL SCIENCE AND MATHEMATICS

3319 N. 14th St., Milwaukee, Wis.

E. L. HUFF TEACHERS AGENCY

MISSOULA, MONTANA

Member Nat'l Assn. Teachers Agencies

Alaska to New Mexico

Normal and College graduates only. Enroll NOW for the best positions in 1932. Special reference service for independent applications. 1932 Certification Booklet FREE with enrollment. 16 years' experienced, personal service.

ADVERTISING PAYS

When your ads are run regularly in SCHOOL SCIENCE and MATHEMATICS

Our Rates are low. Compare them with other educational journals.

We reach the buyers of scientific apparatus and books.

Reserve space and send copy for our next issue to

SCHOOL SCIENCE AND MATHEMATICS W. F. Roecker, Bus. Mgr. 3319 N. 14th St., Milwaukee, Wis.

Please mention School Science and Mathematics when answering Advertisements.

Universities, and Frank M. McMurry, Teachers College, Columbia University. Cloth. Pages vi+506. 452 illustrations. 38 colored maps. 19x25.5 cm. 1932. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.60.

Mathematical Nuts by Samuel I. Jones, Assistant Secretary and Treasurer of the Life and Casualty Insurance Company, Nashville, Tenn., and formerly Professor of Mathematics in David Lipscomb College, Nashville, Tenn. Cloth. Pages x+340. 12.5x19 cm. 1932. Samuel I. Jones, Life and Casualty Bldg., Nashville, Tenn. Price $3.50.

Mastery Units in Physics by Clifford Holley, Instructor in Physics, University of Chicago High School, and Vergil C. Lohr, Instructor in Physics, University of Chicago, also Instructor in Physics at Central Y. M. C. A. College, Chicago. Cloth. Pages xvii+700. 13.5x19.5 cm. 1932. J. B. Lippincott Company, 1249-1257 S. Wabash Avenue, Chicago, Illinois. Price $1.88.

Perkin and Kipping's Organic Chemistry, entirely New Edition by F. Stanley Kipping, Professor of Chemistry, University College, Nottingham, and F. Barry Kipping, University Demonstrator in Chemistry, Trinity College, Cambridge. Part I. Cloth. Pages xi+614+xxix. 12.5x18.5 cm. 1932. J. B. Lippincott Company, 1249-1257 S. Wabash Avenue, Chicago, Illinois. Price $3.50.

Standards for High School Teaching by Charles Everand Reeves, Professor of Education, Elmira College, Elmira, New York. Cloth. Pages xii+558. 13x18.5 cm. 1932. D. Appleton and Company, 35 West 32nd Street, New York. Price $2.50.

Plane Geometry by Elizabeth Buchanan Cowley, Teacher of Mathematics, Allegheny Senior High School, Pittsburgh, Pa. Cloth. Pages xii+368. 13x18.5 cm. 1932. Silver, Burdett and Company, 39 Division Street, Newark, New Jersey. Price $1.40.

Medical Entomology, A Survey of Insects and Allied Forms which affect the Health of Man and Animals by William A. Riley, University of Minnesota, and Oskar A. Johannsen, Cornell University. First Edition. Cloth. Pages xi+476. 14x23 cm. 1932. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York. Price $4.50.

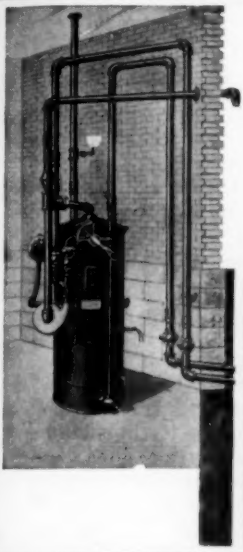
National Society for the Study of Education, Thirty-first Yearbook, Part I. A Program for Teaching Science prepared by the Society's Committee, S. Ralph Powers, Chairman. Pages xii+370. 15x23 cm. 1932. Public School Publishing Company, 509-513 Northeast Street, Bloomington, Illinois. Price, Cloth Bound, $2.50; Paper Covered, $1.75.

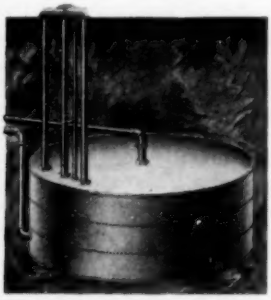
The National Council of Teachers of Mathematics Fifth Yearbook. The Teaching of Geometry. Cloth. Pages x+206. 15x23 cm. 1930. Bureau of Publications, Teachers College, Columbia University, New York. Price $1.75.

The National Council of Teachers of Mathematics Sixth Yearbook, Mathematics in Modern Life. Cloth. Pages ix+195. 15x23 cm. 1931. Bureau of Publications, Teachers College, Columbia University, New York. Price $1.75.

The National Council of Teachers of Mathematics Seventh Yearbook, The Teaching of Algebra. Cloth. Pages ix+179. 15x23 cm. 1932. Bureau of Publications, Teachers College, Columbia University, New York. Price $1.75.

Workbook in High School Observation and Practice Teaching by Charles Everand Reeves, Professor of Education, Elmira College, Elmira, New York. Paper. Pages viii + 270. 20 x 28 cm. 1932. D. Appleton and Company, 35 West 32nd Street, New York. Price $1.00.





ELECTRICALLY OPERATED
AUTOMATIC GAS MACHINE
Requires No Attention

Write to us for list of colleges and high schools using our machine. Illustrated Catalogue Will Be Sent on Request.

MATTHEWS GAS MACHINE CO.
192 N. Clark Street **CHICAGO, ILL.**

This Machine Will
Automatically
Produce
GAS

For your laboratories and Domestic Science Department.

In use in hundreds of educational institutions throughout the country.

Experienced placement authorities in charge of every phase of educational activity. Our work includes positions from college executives to primary and kindergarten teachers. Excellent librarians, secretaries, teachers of physical education and home economics are on our lists. *Write for information.*

Fisk TEACHERS AGENCY CHICAGO

OUR SERVICE IS NATION-WIDE

Address 850 STEGER BLDG., Chicago, Illinois

Visit us in Washington, D. C., N. E. A. Convention—Booth 61

CLARK-BREWER
50th Year

Registration in one office joins all

Chicago—64 E. Jackson
New York—Flatiron Bldg.
Kansas City—N. Y. Life Bldg.
Minneapolis—Globe Bldg.
Spokane—Columbia Bldg.

COLLEGE DEPT.
for A.M.'s & Ph.D.'s
Large Suburban Clientele

ALBERT TEACHERS AGENCY
25 E. Jackson Blvd., Chicago.
535 Fifth Avenue, New York.
415 Hyde Building, Spokane.

For Science and Mathematics Teachers

46TH YEAR.—Professors of Science and Mathematics in demand for work in Universities, Colleges, State Teachers' Colleges. Also teachers of Science and Mathematics for good paying positions in Private Schools, and High Schools. Write today.

TEACHERS, WE PLACE YOU IN THE BETTER POSITIONS

ROCKY MT. TEACHERS' AGENCY
410 U. S. NATL. BANK BLDG. WILLIAM RUFFER Ph. D. MGR. DENVER COLO.
BRANCH OFFICE
LUMBER EXCHANGE
MINNEAPOLIS MINN.

Largest Teachers' Agency in the West. We Enroll Only Normal and College Graduates. Photo copies made from original, 25 for $1.50. Copyrighted Booklet, "How to Apply and Secure Promotion with Laws of Certification of Western States, etc., etc., etc.," free to members, 50c to non-members. Every teacher needs it. Write today for enrollment card and information.

THE GRADUATE EDUCATION BUILDING OF THE UNIVERSITY OF CHICAGO

The University of Chicago has a new building which is in many respects unique among American university buildings. It is known as the Graduate Education Building. It was erected with a part of the $1,500,000 given to the University by the General Education Board for the support of the scientific study of educational problems.

The General Education Board selected the University of Chicago as a center for development of the science of education for two reasons. First, the Middle West has in recent years been more vigorous in educational experimentation, in enrichment of school curriculum, and in reform of methods of teaching and of school administration than any other section of the United States or any other part of the civilized world. Second, the contributions of the Department of Education of the University of Chicago to the science of education have been so conspicuous as to justify fully the expectation that increased contributions to this science will be insured by added equipment.

The new Graduate Education Building shows that an entirely new idea with regard to the science of education is beginning to be accepted. This building has a statistical laboratory, a fully equipped apparatus workshop with a skilled mechanic, dark rooms for photographic work, laboratory rooms, record rooms, work rooms for members of the staff engaged in school and college surveys and other studies in the field of school and college administration, and a library with work space for 200 students and stack space for 100,000 volumes. The stack now contains 60,000 volumes on education. There is a special-collection room, where reports of school systems and colleges are made available for students of educational administration.

In addition to the equipment described, there are office workrooms for the fifteen professors and the fourteen staff members of lower academic rank who give instruction in the department. The building is devoted strictly to graduate work. It stands between the two buildings which house the Laboratory Schools. With the older buildings now occupied by the Laboratory Schools and with the school gymnasium, which is one of the most complete in the country, the Department of Education has a plant which is not surpassed by any of the plants provided for the natural and social sciences, which were recognized in universities before the science of education came into being.

The American Botanist

Edited by Willard N. Clute

The only journal of popular botany in the world. An unfailing source of information about plants. Invaluable for developing an interest in Botany in your classes.

Quarterly, 64 pages, $2 a year.
Sample 10c.

WILLARD N. CLUTE & CO.
Butler University Indianapolis, Ind.

The Central Association of Science and Mathematics Teachers

A progressive, influential, organization. $2.50 pays your membership and brings you the official journal for one year. Send membership dues to **Ersie S. Martin,** *Treasurer,* Arsenal Technical High School, Indianapolis, Indiana.

Please mention School Science and Mathematics when answering Advertisements.